

APR 20 1961

APRIL 1961

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CANADIAN ELECTRONICS ENGINEERING

Radio must meet the challenge of listeners' changing needs

Studio control equipment — the evolution of the package

Paper tape permits automatic programming of radio stations

FEATURE REPORT: Broadcasting in Canada



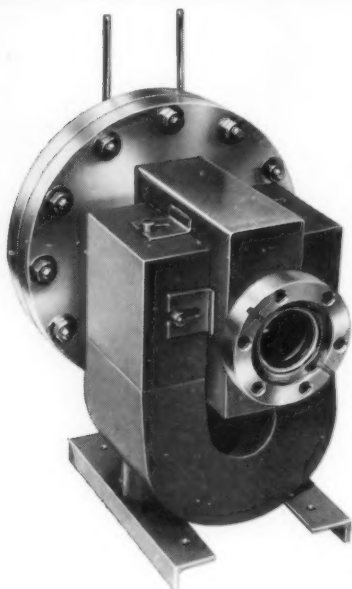
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CANADIAN ELECTRONICS ENGINEERING

Volume five number

4

April 1961

Canadian broadcasting forges ahead

Editorial comment

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Survey shows broadcasters' needs

CEE has recently completed a survey in which a questionnaire was sent to all of Canada's private broadcasting stations and to CBC headquarters. Here are the results of the survey in a condensed report. Readers who want further information on particular aspects of this study are invited to write to the editor.



36

Radio must meet the challenge of listeners' changing needs

In the past few years radio has undergone a major change. It has become a constant companion for most people and is associated with their daily activities. Radio station personnel must adapt to the new techniques and concepts to keep up with listener needs.



Douglas C. Trowell has been station manager of CFPL Radio, London, since 1956, after nearly ten years with the station, where he announced, wrote copy and sold time locally, working his way up to sales manager. He is a former officer of the Central Canada Broadcasters' Association and has been a director of the Sales and Ad Club, and (national) Sales Executives Association in London.

38

TV receiver radiation interferes with AM reception

Broadcast consultants, Hoyles, Niblock and Associates have been investigating the interference with AM reception caused by television receiver radiation. These are the highlights of their interim report presented to the CAB.

40

The evolution of the package

The growing complexity of operating procedures in modern radio and television studios, and the need to keep operating costs at a minimum have led to the evolution of packaged control consoles. This is a discussion of the main design considerations with examples of new packaged equipment utilizing best compromises.



John R. Simpson served five years in the RCAF as an electronics instructor before joining Canadian General Electric Co. Ltd. to install radar equipment. A year later he went to Electronic Associates Ltd. and spent four years with their technical publications division. In 1959 he joined Automatic Electric Sales (Canada) Ltd. as a radio systems specialist. Late last year he formed his own company, Technical Marketing Services.

41

Paper tape control permits automatic programming of radio stations

An automatic programming system has been developed at radio station CFPL, London, to permit unattended operation of the station at night. It is controlled by punched paper tape. This article is based on a paper delivered to the Western Association of Broadcasters, Calgary.



Glen A. Robitaille joined CFPL Radio, London, in 1949 as technical director. He entered radio in 1934 with CKWX, Vancouver. Between 1942 and 1945 he lectured in radio and TV theory at the RCAF station in Clinton. Prior to joining CFPL he was junior engineer at RCA Victor Co. Ltd., Montreal where he participated in the planning, installation and proof of performance of 15 Canadian radio stations. See page 43 for further information.

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General Instrument Semiconductor

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OF QUALITY ZENER DIODES

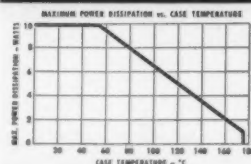
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Type	Zener Voltage (V)	Test Cur. @ 25°C (mA)	Max. Dyn. Imp. (ohms)	Type	Zener Voltage (V)	Test Cur. @ 25°C (mA)	Max. Dyn. Imp. (ohms)	Type	Zener Voltage (V)	Test Cur. @ 25°C (mA)	Max. Dyn. Imp. (ohms)	Type	Zener Voltage (V)	Test Cur. @ 25°C (mA)	Max. Dyn. Imp. (ohms)
1N1808	9.1	500	1	1N1588	3.6-4.3	150	2.6	1N1518	3.6-4.3	50	9	1N708	5.6	25	3.6
1N1351	10	500	2	1N1589	4.3-5.1	125	2.3	1N1519	4.3-5.1	40	8.5	1N714	10	12	8
1N1352	11	500	2	1N1590	5.1-6.2	110	1.4	1N1520	5.1-6.2	35	5.5	1N718	15	12	13
1N1353	12	500	2	1N1591	6.2-7.5	100	.58	1N1521	6.2-7.5	30	1.6	1N721	20	4	20
1N1355	15	500	2	1N1592	7.5-9.1	80	.5	1N1522	7.5-9.1	25	1.1	1N723	24	4	28
1N1357	18	150	3	1N1593	9.1-11	70	.7	1N1523	9.1-11	20	1.5	1N731	51	4	115
1N1358	20	150	3	1N1594	11-13	50	1.4	1N1524	11-13	15	2.4	1N735*	75	2	240
1N1359	22	150	3	1N1595	13-16	40	3.4	1N1525	13-16	13	5.4	1N738*	100	1	400
1N1360	24	150	3	1N1596	16-20	35	6	1N1526	16-20	10	11	1N742*	150	1	860
1N1361	27	150	3	1N1597	20-24	30	9	1N1527	20-24	9	18	1N744*	180	1	1200
1N1362	30	150	4	1N1598	24-30	25	13	1N1528	24-30	7	28	1N745*	200	1	1400

*Supplied with $\pm 10\%$ tolerance only.

†Intermediate values supplied with $\pm 5\%$ tolerances on order.

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CANADIAN ELECTRONICS ENGINEERING APRIL 1961

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Wide range of new equipment is used in Canada's television stations

The recent opening of Canada's second-channel television stations has focused attention on the wide variety of new equipment available. We present here a round-up of some of the latest items, keyed so that you can use our Reader Service cards to get further information.



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New facility tests special purpose tubes

A testing laboratory for camera tubes has been in operation at Canadian Marconi's Electronic Tube and Components Division in Toronto for the past two years. Its facilities have now been extended to provide for pretesting special purpose tubes. Customers receive only tested tubes and warranty actions are speeded up.



54

Adam Gelbtuch

Since publication of the February issue of CEE additional biographical information about Adam Gelbtuch (Design curves aid proper utilization of thermoelectric devices) has been received. Mr. Gelbtuch studied physics at the combined Kiev-Kharkov University and then graduated from the Im-

perial College, London. Although he did not work with either Professor A. F. Ioffe or Dr. Still'Bans, as stated in the February issue, he was familiar with Dr. Still'Bans' work and was a personal friend of Professor Ioffe. Mr. Gelbtuch is a director of Semiconductor Thermoelectrics, Ltd., London.

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CANADIAN ELECTRONICS ENGINEERING

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Hold 10% line-voltage variations to 0.25%

Output voltage adjustable over a $\pm 10\%$ range from a base value of 115 volts.

Correction range in percent of output voltage	$\pm 10\%$	$\pm 20\%$
Output current in amperes	50	25
KVA	5.75	2.9
Correction accuracy as percent of nominal output voltage	$\pm 0.25\%$	$\pm 0.5\%$
Correction speed in volts per second	10	20

- ... Without introducing waveform distortion...
- ... At continuous loads up to 50 amperes and short-time surges up to 500 amperes...
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NEWS HIGHLIGHTS

New working arrangement for TV channel allocations concluded between DOT and FCC

The allocation and use of TV channels within 250 miles of the international border are governed by the Canadian-U.S. Television Agreement of 1952. That agreement is still in full force but the new arrangement gives the Canadian Department of Transport and the U.S. Federal Communications Commission a common set of standards by which to determine if a proposed channel allocation will likely be acceptable to both governments under the 1952 agreement. DOT has also issued new rules, effective April 1, governing the allocation of channels in Canada, designed to better meet public needs for expanded TV coverage.

Aircraft collision warning system may be manufactured in Canada

A system that would warn an aircraft pilot of an impending collision from any direction and prescribe a proper escape manoeuvre has been revealed by Sperry Gyroscope Co. of Canada Ltd. Developed by Sperry's U.S. parent company, the system is now undergoing rigid flight tests by the Federal Aviation Agency. "Should these tests prove as successful as we expect," said Sperry's Canadian managing director B. W. King, "we might well be involved in the manufacture and sale of this system to Canadian air carriers."

Aeromagnetic survey program bodes well for communications companies

It is a well-established fact that full-scale development of Canada's northern mineral resources will pro-

vide increased markets for our manufacturers of long-distance communications equipment. So there was welcome news in the announcement of an \$18-million federal-provincial aeromagnetic survey program which will cover 1,800,000 square miles and telescope into 12 years what would, at current rates of progress, have taken 60 years to complete. The provinces will pay half of the \$12 million to be spent on unsurveyed parts of the Canadian Shield within provincial boundaries, and the federal government will pay the full \$6 million for the Northwest Territories and Yukon.

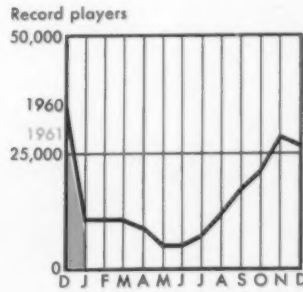
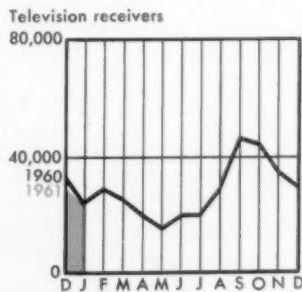
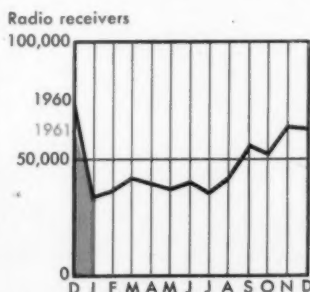
Raytheon Canada and Canadian Marconi announce R & D pact

Although details of the first contract are still highly secret, the research and development agreement recently concluded between Raytheon Canada Ltd., Waterloo, Ont. and Canadian Marconi Co., Montreal is known to be centred on Marconi's established competence in long haul broadband microwave radio relay equipment and systems. Raytheon Canada president John R. Cann refers to the contract as the start of "increased co-operation between the two companies." Marconi's DQ58B units were selected by the RCAF for the 1500-mile Adcom II system, and the newer DQ58C is being produced for the Manitoba Telephone System.

Canada's \$750,000 space program is right on schedule with antenna trials planned for June and top-side sounder satellite to be launched in the spring of 1962

Watch for full story and pictures in CEE, May.

January radio and tv sales hold their own with 1960 levels



Distributor sales to dealers, in units

Source: EIA of Canada / Charts: CEE

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2N1199	12-60(DC)		tr 35 μ sec ts 10 μ sec tf 25 μ sec
2N1267	6-18	25 db	
2N1268	11-36	at 4.3 mc	
2N1269	28-90		
2N1270	6-18	25 db	
2N1271	11-36	at 12.5 mc	
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Maximum V_{cb} —20 V
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2N1199

This high speed switch has exceptionally low saturation voltage (typically 0.125 V), permitting practical design of 5 mc pulse circuits, using conventional saturated switching configurations. 30 mc pulse rates are obtainable in practical circuits using non-saturating techniques.

2N1267-68-69

The high gain characteristics of these units make possible the design of high efficiency IF amplifier circuits for communications equipment. These devices have unusually low collector capacitance . . . typically 1.5 μ f . . . and are available with restricted beta ranges to simplify design problems.

*SADT... Trademark Philco Corp. for Surface Alloy Diffused-base Transistor

2N1270-71-72

The excellent high frequency response of these transistors makes practical the design of high performance communications systems at frequencies up to 60 mc. They have the same low collector capacitance and are available with restricted beta ranges.

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Please send complete information on the SADT type transistors and descriptive brochure of all type transistors available.

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CANADIAN ELECTRONICS ENGINEERING APRIL 1961

Dr. Porter accepts position at University of Toronto



Dr. Arthur Porter, Dean of the College of Engineering at the University of Saskatchewan, has been appointed the first Professor of Industrial Engineering at the University of Toronto. The appointment becomes effective July 1.

Dr. Porter is an expert on the electrical control system which, among other things, make possible large-scale automation of industry. He worked in Toronto from 1949 to 1955 as head of the research division of Ferranti Electrical Ltd., (now Ferranti-Packard Electric Ltd.). From 1955 to 1958 he was Professor of Light Electrical Engineering at the Imperial College of Science and Technology, London. He went to the University of Saskatchewan in the fall of 1958 to succeed Dean I. M. Fraser who had retired. He was responsible for the introduction of engineering science courses for those students of superior intelligence. Engineering scientists, he said, are those who will have the knowledge to "produce goods and to provide services using the most up-to-date methods and the most advanced scientific principles."

Dr. Porter becomes the first member of the University of Toronto staff to be associated solely with the new course in Industrial Engineering, which superseded the Engineering and Business course two years ago. The new course covers areas of fundamental engineering and science, but is heavily weighted toward mathematics. Its undergraduates study operations research, electronic data processing, control theory, numerical analysis, probability and statistics.

I. H. Karten, president of Multitone Electronics Ltd., formerly Multitone of Canada Ltd., has announced staff appointments:

T. W. H. Stoddart becomes vice-president and general manager with executive responsibilities for the company's operations in North America.

G. W. Crossan becomes sales manager for Multitone Personal Call paging systems and associated products.

A. G. Quin becomes accountant and office manager with headquarters in Toronto.

H. J. Scheibner becomes service manager responsible for technical service at the company's Toronto and Buffalo, N.Y., service centres.

Donald F. Wright has been appointed manager, General Communications Engineering in the Canadian Westinghouse Electronics Division.

Mr. Wright joined the company in 1958 as an advisory engineer.



Wright



Matthews



Bridgman



Miller

Richard P. Matthews, P.Eng., has been elected vice-president and a director of Andrew Antenna Corp. Ltd.

He will continue to fill the position of general manager to which he was appointed in 1958. Mr. Matthews, born in Regina, received his B.A. and B.E. (engineering physics) degrees from Regina College and the University of Saskatchewan. He is a senior member of IRE and a member of AIEE.

Manager of Defence Systems Service Division of Burroughs Business Machines Ltd. (formerly Burroughs Adding Machine of Canada Ltd.) is G. E. McMurtrie.

In his new position, Mr. McMurtrie will be in charge of planning, installing, maintaining and operating military systems and performing other field support activities in connection with

military contracts held by Burroughs in Canada. He will also supervise training at the defence systems service division's school in Toronto.

Mr. McMurtrie joined Burroughs in November, 1959 as industrial relations manager and was made operations manager in March of the following year. He holds a BSc degree from Acadia University and a master's degree in mathematics and physics from the University of British Columbia. Before joining Burroughs, Mr. McMurtrie worked as assistant to the director of nuclear physics at A.E.C.L., Chalk River, and was wage and salary administrator for Avro Aircraft Ltd.

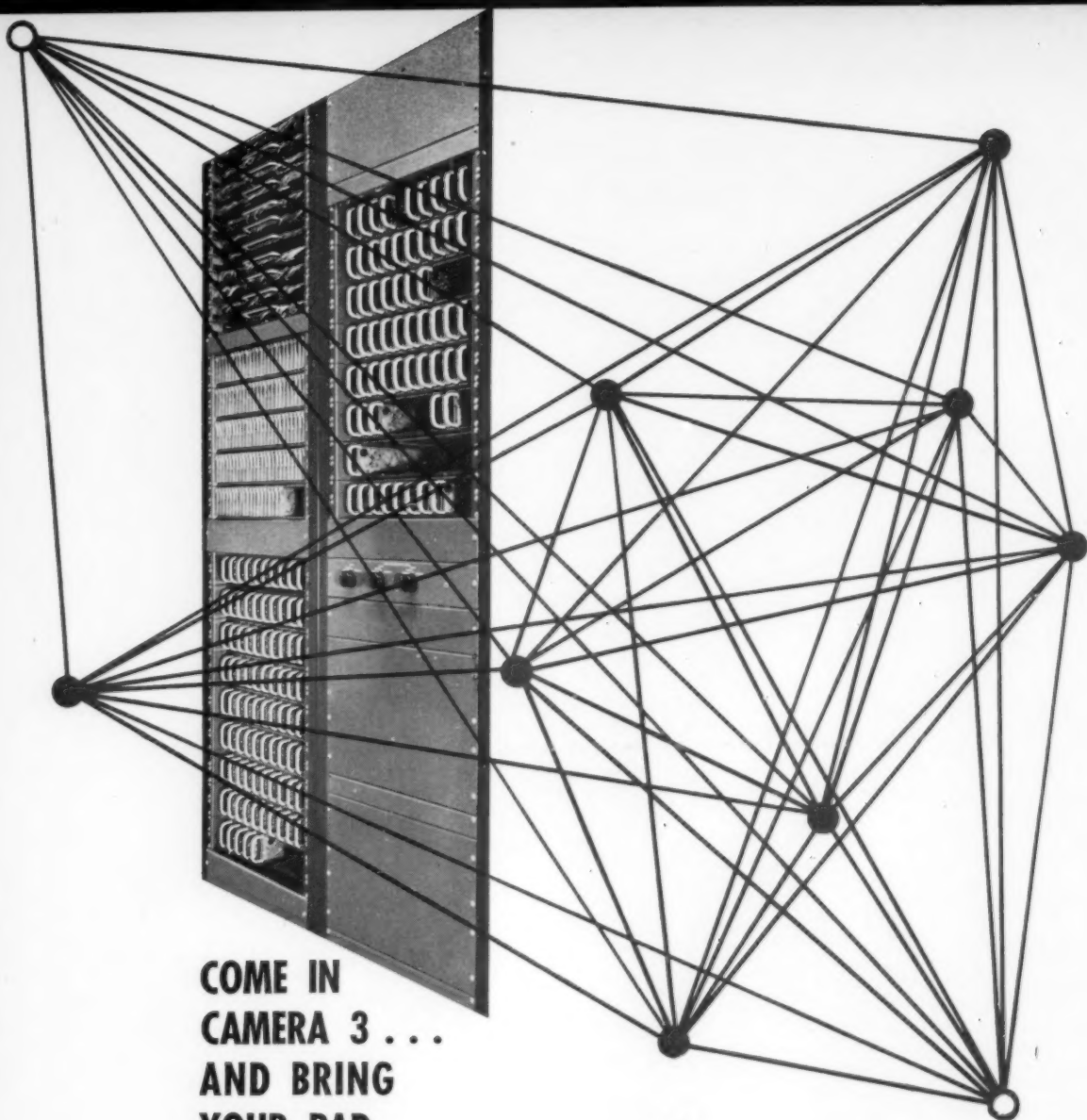
J. M. "Monty" Bridgman has been appointed vice-president and general manager of Litton Systems (Canada) Ltd.

Mr. Bridgman has been serving since November 1959 as manager of the firm. Previously he was executive vice-president and general manager of Canadian Applied Research Ltd., a division of A. V. Roe Canada Ltd., and has been active in the Canadian aviation industry since leaving the RCAF in 1947. In the RCAF he served as a signals officer, specializing in radar and other electronic devices, retiring with the rank of squadron leader.

RCA Victor Co. Ltd. has appointed E. W. Miller as manager of technical products marketing for the Quebec area.

Mr. Miller served with the RCAF for five years during World War 2 before completing his studies at McGill and Laval Universities. After graduation in 1948 he joined RCA Victor's engineering products department. In 1953 he left the company to head up the technical department of CFMT-TV in Quebec City, and was later appointed manager of the station.

In 1958 he moved to Cornwall to design and establish CISS-TV, and on completion of the station he became president and general manager. In 1960 he left that position to undertake consulting work for the broadcast industry, and prepared preliminary plans for CHOY-TV, Pembroke, now under construction.



COME IN CAMERA 3 . . . AND BRING YOUR PAD

To most people, intercom is a convenience around the office, but to the people concerned with television production, it is a vital network connecting widely separated points which must exchange information on a split-second schedule.

Since it permits custom engineering of facilities of any desired scope and complexity, the McCurdy SS1026 Packaged TV Intercom System ensures that the right points are connected. And since its solid-state modular components can be assembled, wired and completely tested prior to installation, the SS1026 also ensures that the right information arrives at the right point at the right time, and is understood by the right people.



MCCURDY RADIO INDUSTRIES LIMITED
22 FRONT STREET WEST, TORONTO 1, ONTARIO

Three companies join in bid for U.S. defense sharing orders

The team approach, in which several companies make a consolidated bid on larger defense jobs, has come to Canada with the formation of **DFC Systems Ltd.** in February.

Three companies—The de Havilland Aircraft of Canada Ltd., Canadian Aviation Electronics Ltd., Ferranti-Packard Electric Ltd. — have established the new subsidiary in a bold effort to get some of the larger U.S. defense sharing contracts into Canadian plants. De Havilland has the controlling interest in DCF and three of the five directors of the new company.

First project is working with Boeing Airplane Co. on test and calibration at the North Bay, Ont., Bomarc base. This may be extended to include the northern Quebec base. It is also possible that DCF may take over full Canadian management of the \$244-million Bomarc program.

General manager of DCF is **William H. Jackson**, assistant to the managing director at de Havilland. Other directors are: D. B. Annan, general manager, Special Products Division, and L. D. Clarke, contracts manager, both of de Havilland; John F. Tooley, president of CAE; and John Fogarty, vice-president and general manager of Ferranti-Packard's Electronics Division. Head office will be at Downsview, Ont.

Representatives take on new lines

Associated Electronic Components Ltd., Toronto, are now the Canadian agent for **Alma Components Ltd.**, London, England (precision wire-wound resistors).

The Glendon Co. Ltd., Toronto has been appointed Ontario sales rep. for **S. G. Smallwood & Co. Ltd.**, Kitchener, Ont. (coils, transformers, solenoid and toroidal windings).

Sperry Gyroscope Ottawa Ltd. are now manufacturing and marketing in Canada all products of **Industrial Timer Corp.**, Newark, N.J. (synchronous motor driven industrial timing controls, punched card and punched tape programming equipment, Time-O-Lite professional and industrial photographic products).

Quan - Tech Laboratories, Inc., Boonton, N.J., has appointed Conway Electronic Enterprises Reg'd., Toronto, as their Canadian distributor (transistorized power supplies and component-noise measuring equipment). Conway have also been appointed Canadian rep. by **Fairchild Camera and Instrument Corp.**, New York, N.Y. (oscilloscope recording cameras).

(Continued on page 62)



Air Commodore R. H. Bray, right, joins Canadian Westinghouse executives H. N. Muller, J. D. Campbell and G. P. Adamson in inspection of the first NASARR fire control unit, which was turned over to the RCAF recently at the company's electronics division. In addition to a \$20-million program for Canada's CF-104, the Hamilton firm has also been awarded a \$2.5-million contract to build NASARR radar components for the defense aircraft of Japan and West Germany, won in the face of stiff competition from other countries.

Ottawa report

If you are manufacturing a product you believe could fill a market now dominated by imports a check with the Trade Department's Industrial Development Branch should provide an answer.

The branch, on request, and only if the manufacturer is seriously considering starting a new line of production, will run a free market survey of competitive imports.

During 1960 the branch greatly expanded this line of work and plans further expansion this year.

Studies of imports, broken down into small specific items, are available on about 40 groups of products. One major survey completed is that on electrical goods valued at \$26 million. The original customs items — the only ones shown in normal Bureau of Statistics reports — have been broken down into about 1,500 parts, components and pieces of equipment listed alphabetically by value of imports and by quantity.

In addition the branch can give information on whether the imports are "captive" (going from parent to subsidiary), their geographical distribution and original foreign sources. This kind of market survey is almost impossible for a manufacturer to do by himself.

Confidential reports, prepared on request and sent only to those who ask for them, were sent to 800 of the country's 37,000 manufacturers, including most of the major firms.

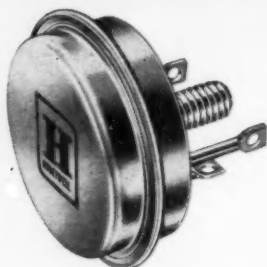
The Commons Committee on Research will branch out into new fields this session, calling upon non-government witnesses for the first time.

Operations of the committee in previous sessions centred mainly upon strictly federal government activities. However, during discussions of the role of the National Research Council, they plan to invite

(Continued on page 63)

IMPORTANT POWER TRANSISTOR NEWS FROM HONEYWELL

New power
transistors



3N49, 3N50, 3N51, 3N52: Power tetrodes in new, single-ended cold-weld package mechanically interchangeable with TO-6 case. 15 amp, 94 watt at 25°C, 40, 60 and 80 volts VCB.



2N1658: New medium power general purpose unit in stud-mounted cold-weld package. 1 amp., 15 watt at 25°C, 80 volt VCB.

New low
prices

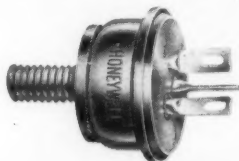
2N538, 2N538A: High quality power transistors at 20% price decrease. 3.5 amps, 32 watt at 25°C, 80 volts VCB.



2N1501, 2N1502: Standard units now in lower price range. 3.5 amps., 32 watt at 25°C, VCB of 40 and 60.

Higher voltage at no
price increase

2N1261, 2N1262, 2N1263: VCB now 80 volts (previously 60). 3.5 amps., 32 watt at 25°C.



Honeywell power transistors are dynamically tested for dependability, assuring you of reliability in your product. Honeywell transistors offer you smaller size per watt output in a complete line of germanium PNP transistors

(1 to 100 watts), 1 to 25 amperes. For application assistance or data sheets, call or write your nearest Honeywell office or Honeywell Controls Limited, *Precision Components Division*, Toronto 17, Ontario.

Honeywell



First in Control
SINCE 1885

For further information mark No. 37 on Readers' Service Card

CANADIAN ELECTRONICS ENGINEERING APRIL 1961

PIONEERING IN PRECISION ENGINEERING



WHERE **IDEAS**
ARE PUT TO FLIGHT

Aviation Electric Limited, established in 1931 to serve Canada's pioneer aviation industry, is today a diversified organization of over 800 highly skilled specialists who fulfill an essential function by designing, manufacturing and overhauling specialized apparatus and equipment.

As the Canadian Affiliate of the Bendix Corpo-

ration, AEL also sells and services a wide range of aircraft and marine products, communications equipment, and specialized industrial equipment.

AEL serves the Department of Defence, R.C.A.F., R.C.N., Canadian Army, leading aircraft manufacturers, leading airlines, as well as smaller air service companies and many private aircraft owners.



AVIATION  ELECTRIC
LIMITED

200 Laurentien Blvd., Montreal, P.Q.

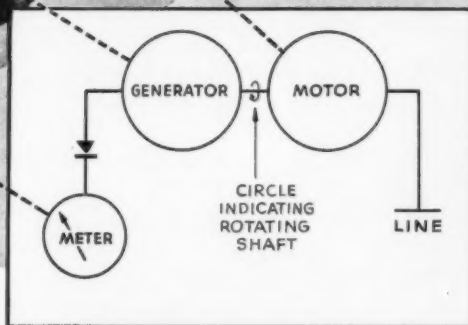
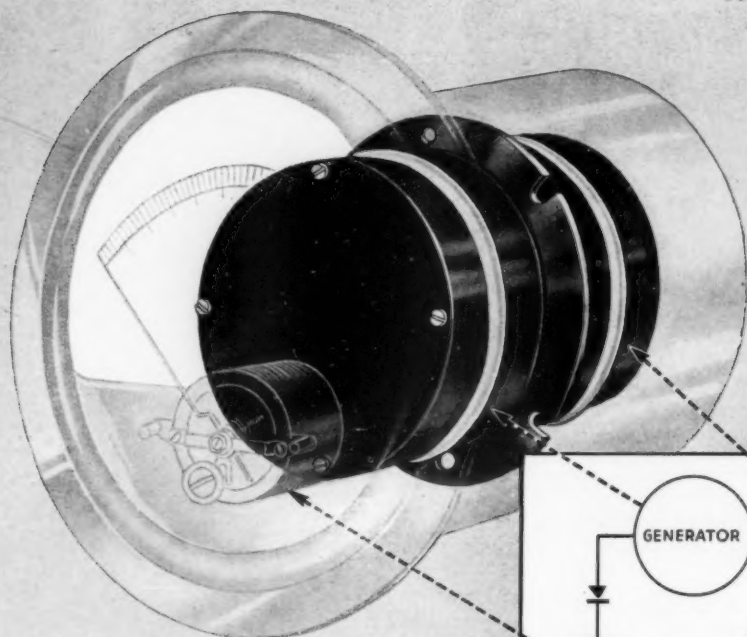
Branch Plant: Aviation Electric Pacific Limited, Vancouver Airport, Vancouver, B.C.

For further information mark No. 15 on Readers' Service Card

*a completely
self-contained*

**FREQUENCY
MEASURING
INSTRUMENT**

*employing
a new
principle !*



The Bach-Simpson **FREQUENCY METER**

Simple in principle, revolutionary in design, the Bach-Simpson Frequency Meter offers these advantages:

★ **INDICATION INDEPENDENT OF VOLTAGE:**

On 110 volt models, for example, input voltage fluctuation between 20 and 200 volts produces no change in indication.

★ **INDEPENDENCE OF WAVE-FORM VARIATION:**

The change from pure sine-wave to square-wave is barely detectable.

★ **COMPACTNESS:**

The miniaturised Motor-Generator which is the heart of the instrument allows a remarkably shallow self-contained unit, with simple two-terminal connection.

★ **LOW POWER INPUT:**

Less than one-half the power input necessary for most pointer type frequency meters is required.

★ **LONG TERM ACCURACY:**

The requirements of the A.S.A. Specification for Grade I Frequency Meters will be met and exceeded throughout the life of the instrument, which, under normal conditions, will be in excess of ten years of continuous operation.

★ **ECONOMY**

Extremely competitive pricing derives from the simplicity of design, and from the elimination of costly and cumbersome accessories.

How does it work? The input voltage drives a synchronous AC Motor and Generator on a common shaft, and the resulting output voltage, proportional to input frequency, is read out on a suppressed zero linearly-scaled meter.

Simple? You can say it in ten seconds. But literally thousands of hours of Canadian Design and Engineering have gone into making this one more of the quality products which Canadian Industry has come to expect from Bach-Simpson Limited.

Your inquiries are invited.



1255 Brydges St., London

K1570

→
at →
**Canadian
Marconi**
→

the only complete Image Orthicon testing lab in Canada

ELECTRONIC TUBE AND COMPONENTS DIVISION

CANADIAN Marconi COMPANY

830 BAYVIEW AVENUE • TORONTO, ONTARIO
BRANCHES: Vancouver • Winnipeg • Montreal • Halifax



factory tested and sealed

Before they leave the factory, all Marconi Image Orthicons undergo extremely critical testing.



studio conditions duplicated

Acceptance tests are conducted when the tubes arrive in Canada. Marconi has built a special lab where the image orthicons are tested under Canadian studio conditions.



fast warranty

This special testing lab enables Marconi to offer immediate warranty adjustment when required.



"total" testing

An extensive series of tests check every detail. Once it has passed these tests, the camera tube is shipped to the studio, sealed and protected by the Marconi guarantee.



visiting studio personnel

Studio engineers and technicians are invited to inspect and make use of these facilities.



tests vary

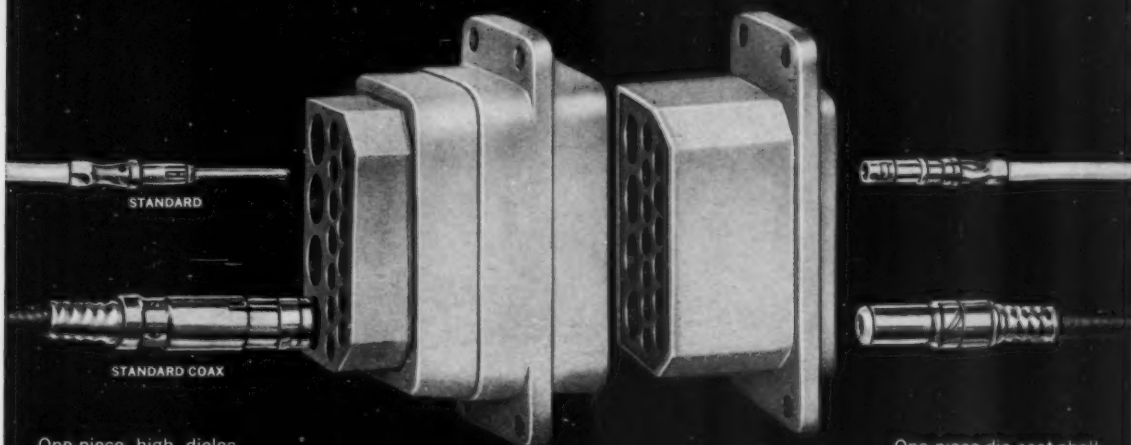
Each of the six types of image orthicons undergoes its own special tests. To test each tube thoroughly takes 30 to 50 minutes.

For further information mark No. 22 on Readers' Service Card

CANADIAN ELECTRONICS ENGINEERING APRIL 1961

HYFEN

RACK and PANEL CONNECTORS



One-piece high dielectric strength insert contains molded-in ferrules for positive contact retention. Eliminates one cause of moisture entrapment.

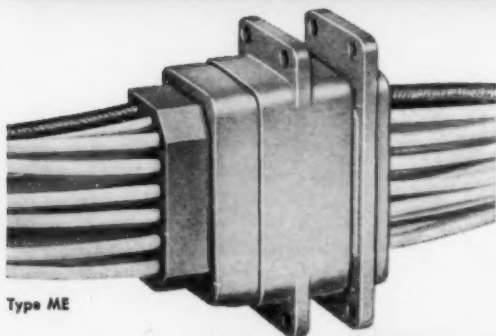
Configurations accommodate three types of contacts: 1. Standard 2. Standard Coax 3. Miniature Coax (below), in any combination. All are plated in accordance with your requirements and are crimp-type, snap-locked HYFEN contacts.

One-piece die-cast shell design permits inserts to be interchanged in shells...allowing dead front in either plug or receptacle.



MINIATURE COAX

crimped-contact reliability—snap-lock versatility



Type ME

PLANT:
SCARBORO, ONT.

Burndy's line of rack and panel HYFEN connectors offers the high reliability of crimp-type, snap-locked contacts. The versatility of the HYFEN technique is increased by the accommodating of a wide range of wire types and sizes... coax, miniature coax and standard cable.

FOR FURTHER INFORMATION CONTACT OMATON DIVISION

BURNDY

TORONTO, ONT.

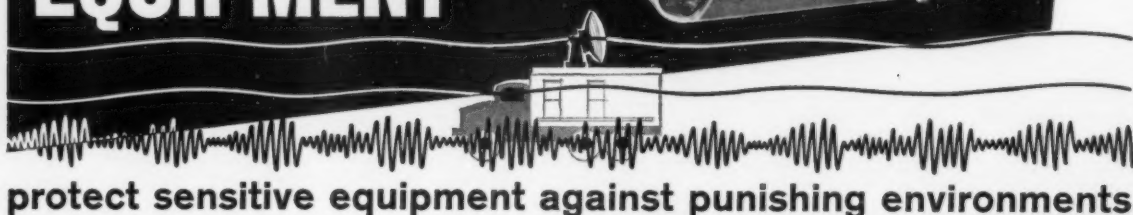
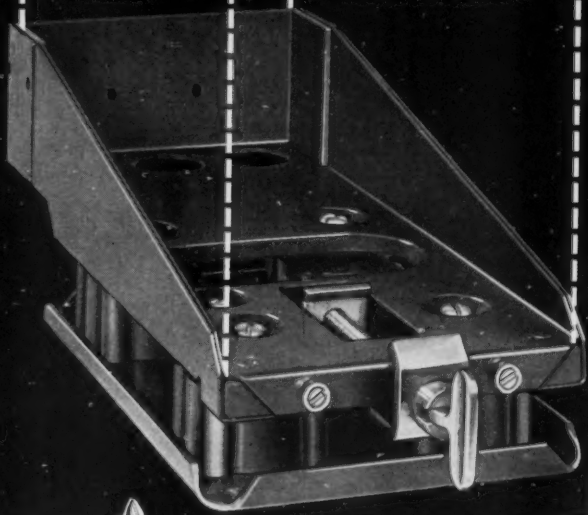
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For further information mark No. 19 on Readers' Service Card

MOUNTING SYSTEMS FOR GROUND SUPPORT EQUIPMENT

- computers
- radar and infra-red
- instrumentation
- recorders

- communications equipment
- check-out and test gear
- control and guidance units
- data processing units



Engineers responsible for the reliability of ground support equipment will find LORD a highly qualified source for resilient mounting systems. Here's what LORD offers:

Optimum performance—assured by custom engineering on overall systems basis, and complete familiarity with vehicular environment.

Advanced techniques—resulting from unceasing research and LORD's 35-year backwork with your vibration/shock/noise control.

Economy—made possible by proved designs, qualified components and extensive facilities for engineering, production and testing.

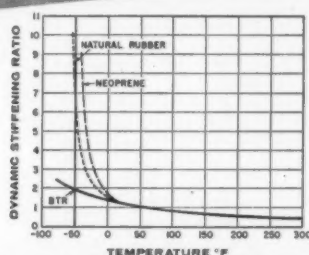
Minimum design time—capable field engineering personnel can be your "right arm" on vibration and shock problems. Close teamwork with your engineers moves your project to final design faster.

Contact the nearest sales office of



RAILWAY & POWER
Engineering Corporation Limited

For further information mark No. 48 on Readers' Service Card



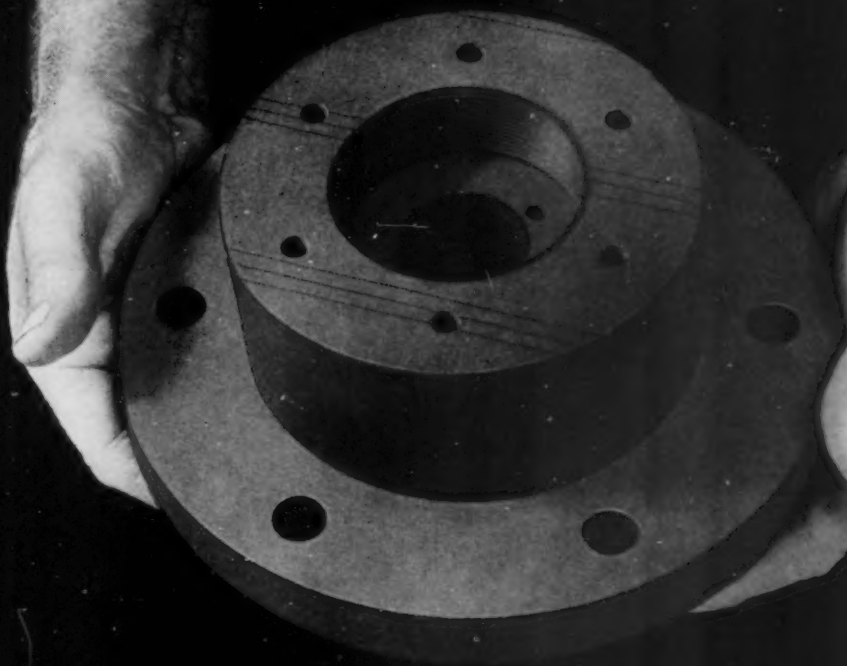
Low-temperature protection is a vital advantage offered by Lord mounting systems. Exclusive Lord BTR® Mountings retain flexibility despite extreme cold, control shock and vibration to -65° F.



NEW GLASGOW • QUEBEC • MONTREAL • NORANDA
NORTH BAY • OTTAWA • TORONTO • HAMILTON
WINDSOR • SAULT STE. MARIE • WINNIPEG
CALGARY • EDMONTON • VANCOUVER

CANADIAN ELECTRONICS ENGINEERING APRIL 1961

FORMICA® field fabricating
Laminated Plastic



now... Streamliner service on fabricated parts



Fabricator of Industrial Formica
laminated plastics

Formica® Field Fabricating
better 3 ways:

- 1 Faster delivery on a totebox-ful or a truckload
- 2 Highest quality assured by fabricating specialists and modern equipment
- 3 24-hr. delivery on standard Formica sheets and rods

Need a part fabricated quickly for prototype development? Need a truckload of parts to keep your production lines running? Your Formica Fabricator-Distributor can *fabricate and deliver* your Industrial Formica laminated plastic parts on a Streamliner schedule—within 24 hours in some cases. He stocks standard Formica sheets for Streamliner delivery in a matter of hours.

The new Formica field fabricating service is without equal. It can save you time and money in more efficient parts procurement. Write us for complete information and the names of our Formica Fabricator-Distributors. Cyanamid of Canada Limited, Laminated Products Department, St. John's, Quebec.



a product of



CYANAMID OF CANADA LIMITED
MONTREAL 2, QUE.

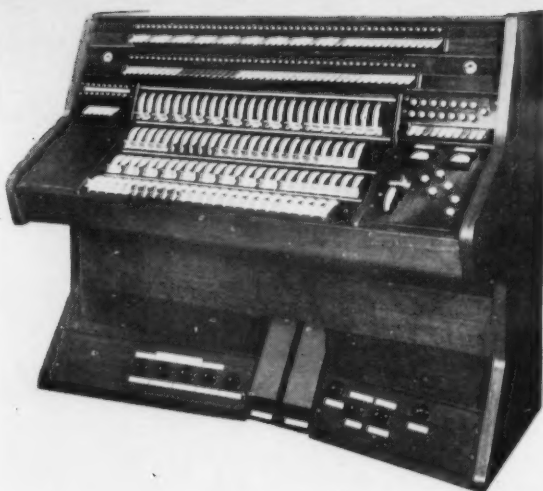
F1-3276

For further information mark No. 27 on Readers' Service Card

CANADIAN TELEVISION TURNS UNANIMOUSLY TO



LIGHTING UNITS AND LIGHTING CONTROL



LIGHTING CONTROL CONSOLE

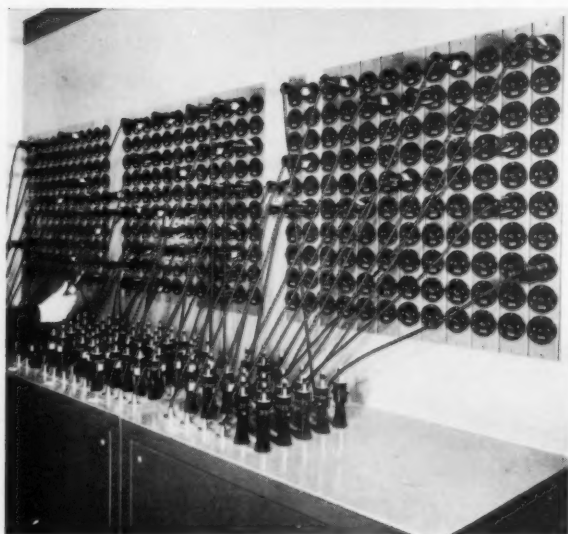
One of three supplied to CFTO's Channel 9 Studios in Toronto. Console provides 14 instantly adjustable memories for group selection and 3 Scene Manual Presets.

PATCH PANELS AT CFTO-TV

Through these patchboards the many circuits at Toronto's Channel 9 Studios are linked to the Control System via the Dimmers. The largest studio has 132 dimmers patching to 400 outlets.

WORLD'S LARGEST DIMMER ROOM

A corner of the dimmer room at CFTO-TV which houses 288 electro-mechanically driven servo-operated dimmers. Other types of Strand dimmer and control systems have been supplied to CJOH-TV Ottawa, CJAY-TV Winnipeg, CHCH-TV Hamilton and CJCH-TV Halifax.



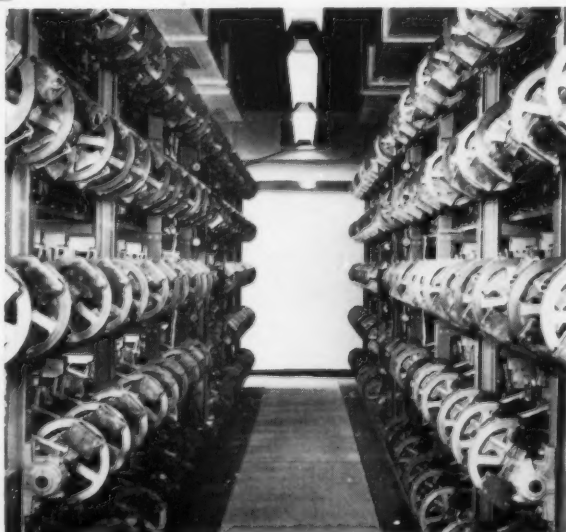
Welcome to the
family circle

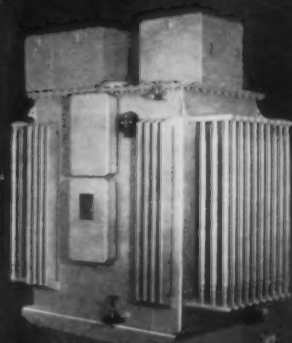


STRAND ELECTRIC LIMITED

755 Yonge Street, Toronto 5

For further information mark No. 58 on Readers' Service Card





G-E Inductrol regulators accurately hold a constant load voltage where incoming supply variations or load fluctuations exist, or provide an adjustable output voltage for any range desired.

Inductrol regulators provide highly accurate, highly reliable voltage control for BMEWS.

GENERAL ELECTRIC INDUCTROL* REGULATORS PROVIDE . . .

Precise, automatic voltage control for Free World's largest radar installation

Automatic $\pm 1\%$ accuracy . . . stepless control . . . maximum reliability. These are just some of the voltage-control requirements for the U.S. Air Force's giant Ballistic Missile Early Warning System (BMEWS). General Electric Inductrol regulators meet them all in providing precise voltage control for both the BMEWS high-voltage transmitter and receiver power supplies.

INDUCTROL REGULATORS offer you these advantages, too, for a wide variety of applications—including radar, communications equipment, rectifiers, computers, laboratory equipment and many others. You also benefit from these other important Inductrol regulator features: drift-free control; 100 percent overload capacity; 97 to over 99 percent efficiency; load, power-factor and frequency compensation; no harmful waveform distortion; and rugged, compact design.

RELIABILITY is inherent in the simple induction principle of General Electric's Inductrol regulator design. There are no tubes to replace, no sliding brushes or contacts to wear out, and no separate d-c power supply. Thus, operation is essentially maintenance-free.

FOR MORE INFORMATION, call your local Canadian General Electric Sales Office, or write Section 457-04B, Canadian General Electric Co. Ltd., Power Transformer Sales, P. O. Box 601, Guelph, Ontario.

* Registered trade-mark of General Electric Company for induction voltage regulators.



**GENERAL ELECTRIC
VOLTAGE REGULATORS**

Apparatus Department

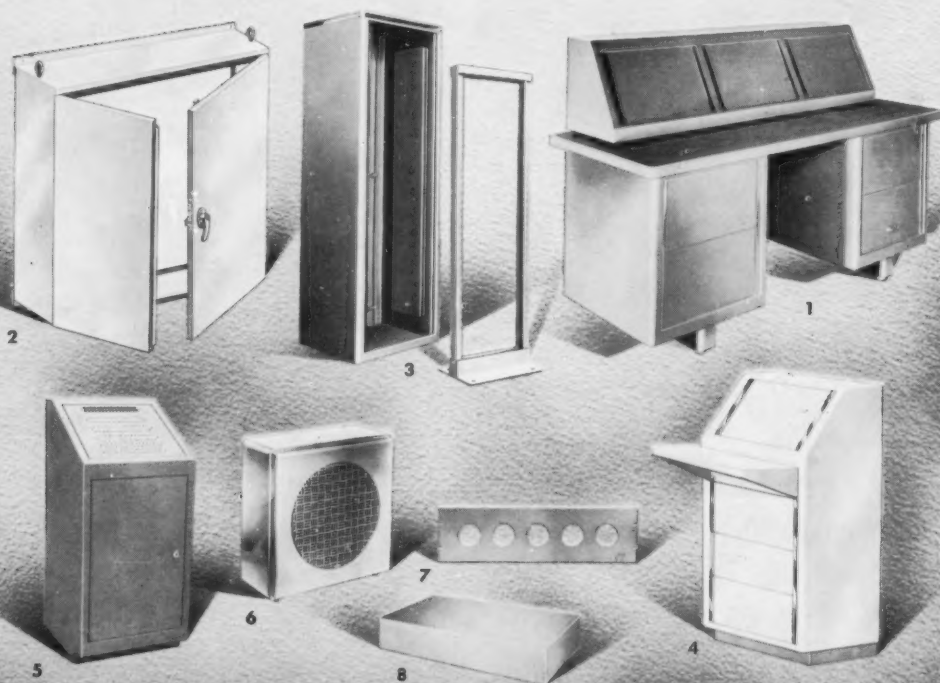
CANADIAN GENERAL ELECTRIC COMPANY LIMITED

For further information mark No. 21 on Readers' Service Card

HAMMOND Electrical and Electronic Cabinetry

Cabinets • Racks • Chassis • Consoles • Tables • Drawers • Speaker Enclosures • Utility Cases • Panels
• Equipment Covers and Enclosures . . . are all part of the Hammond line.

1. Consoles, Tables and Turrets . . . for communication and control systems.
2. Panel Enclosures . . . N.E.M.A. 12 specs., dust, water and oil-spray proof.
3. Cabinets and Racks . . . for mounting and housing electronic equipment.
4. Modular Consoles . . . designed and constructed for multiple groupings.
5. Special Metal Cabinets . . . for electronic controls in industry.
6. Speaker Enclosures . . . for all sizes—table or wall mounting.
7. Rack Panels . . . steel or aluminum, plain or punched.
8. Chassis . . . steel or aluminum . . . constructed for heavy duty service.



Quality metal work economically fabricated!

Hammond's modern plant is equipped to produce durable, finely finished metalwork to close tolerances and high quality standards for Canadian Industry. The factory carries an extensive range of stock items, and dies used for more than 14,000 original metal fabrications are available to produce special requirements at an economical price.



HAMMOND

ELECTRICAL and ELECTRONIC CABINETRY

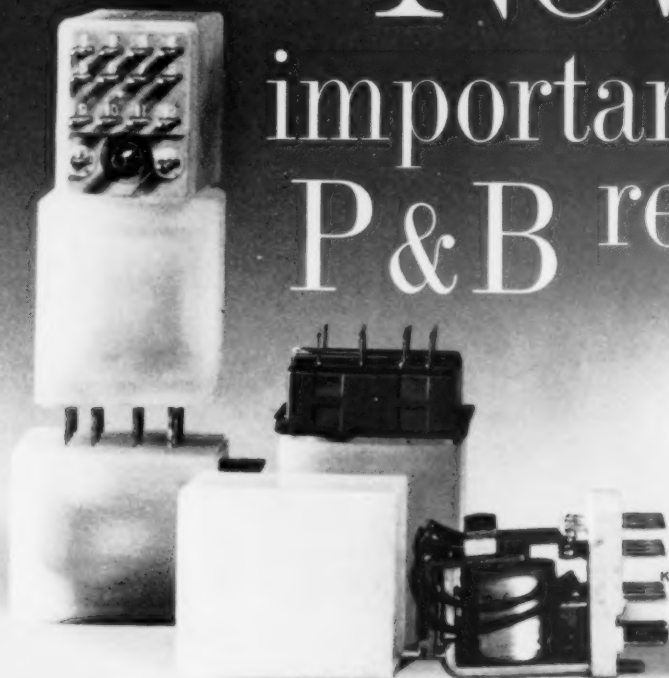
Standard Items Stocked by Leading Jobbers

H3

HAMMOND MANUFACTURING COMPANY LIMITED • GUELPH, ONTARIO, CANADA

For further information mark No. 34 on Readers' Service Card

a New and important P & B relay . . .

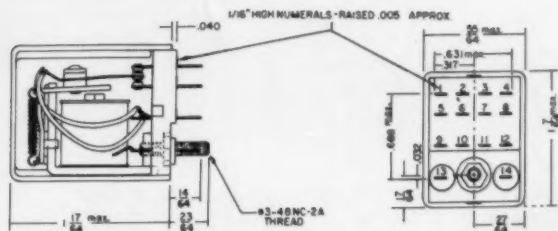


KHP SERIES SHOWN ACTUAL SIZE

having rare longevity

This small, 4-pole relay has the happy faculty of maintaining its original operating tolerances over an exceptionally long life. Example: tests (by customers!) show this relay has variations in electrical characteristics of less than 5% after more than 100 million operations.

But that's far from all. This is a *small* relay . . . about a one inch cube. This relay is easy to install using the conveniently spaced solder lugs or a socket. Thus you save time and production costs. This relay is versatile . . . its 4PDT contacts will switch loads from dry circuit up to 3 amperes. This relay—well, why not order samples and see for yourself! Order today from your P & B representative or write us direct.



KHP SERIES SPECIFICATIONS

CONTACTS:

Arrangement: 4 Form C, 2 Form Z.

Material: $\frac{1}{16}$ " dia. Silver standard. Silver cadmium oxide and gold alloy available.

Rating: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

COILS:

Resistance: 11,000 ohms max.

Temperature: Operating Ambient: -45°C . to $+70^{\circ}\text{C}$.

Power: 0.5 watts min operate @ 25°C . 0.9 watts nom. @ 25°C . 2.0 watts max. @ 25°C .

TIMING VALUES:

Nominal Voltage @ 25°C .

Pull-in time

Drop-out time

Max. Values

15 ms

5 ms

INSULATION RESISTANCE: 1500 megohms min.

DIELECTRIC STRENGTH:

500 Volts RMS 60 cycles between contacts.

1000 Volts RMS 60 cycles between other elements.

MECH. LIFE: In excess of 100 million cycles.

SOCKET: Solder lug or printed circuit terminals. Available as accessory.

DUST COVER: Standard.

TERMINALS: Solder lug and taper tab.

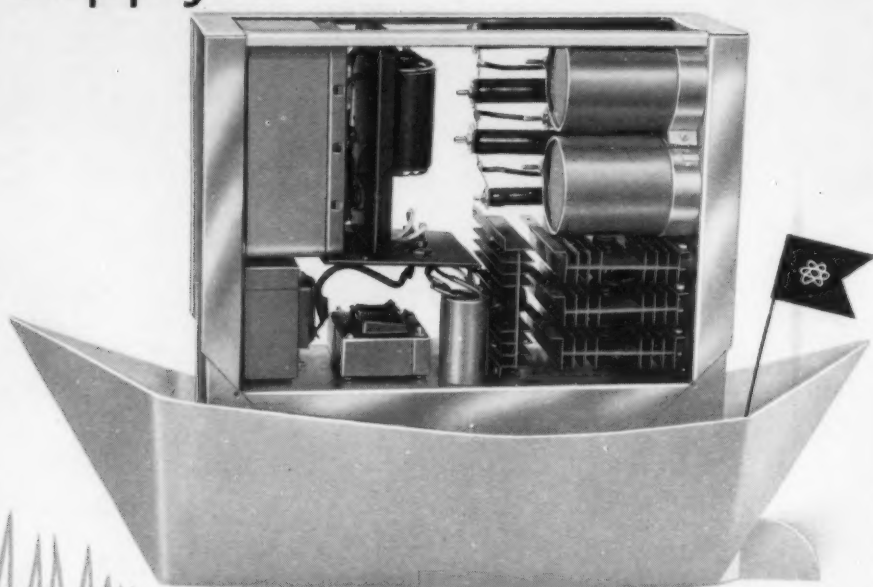
P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



POTTER & BRUMFIELD

DIVISION OF AMF CANADA LIMITED • OXFORD STREET, GUELPH, ONTARIO

new SOLA transistorized d-c supply...



reliably regulates d-c voltage — right down to the last "ripple"!

New highly sensitive SOLA "CVQ" provides transistor-regulated d-c output ideal for computers and other *voltage-sensitive equipment*. Response to voltage change is so rapid the CVQ even attenuates 120-cycle ripple! Yet, with it all, this new d-c supply introduces a revolutionary circuit simplicity — providing significant savings in sizes . . . more watts per dollar!

CVQ combines exclusive transistorized shunt regulation with SOLA's inherently self-protecting, static-magnetic transformer . . . easily meets the most taxing demands of dynamic loading. Voltage holds in spite of widely fluctuating loads. The result is longer equipment life, more trouble-free operation. Contact our area representative for complete specifications and prices. Or write today for literature on CVQ.

- Standard models available at 5, 6, 10 and 12 volts d-c (100-130/181-235/200-260 volt input).
- Output regulated within $\pm 0.04\%$ for line voltage variations $\pm 15\%$; 0.2% static-load regulation, 0 to full load.
- Excellent transient response.
- Inherent protection against output over-voltage safeguards both supply components and external circuitry.
- Short-circuit proof design.
- Compact mechanical layout — only $12\frac{1}{4} \times 5\frac{1}{4} \times 19"$

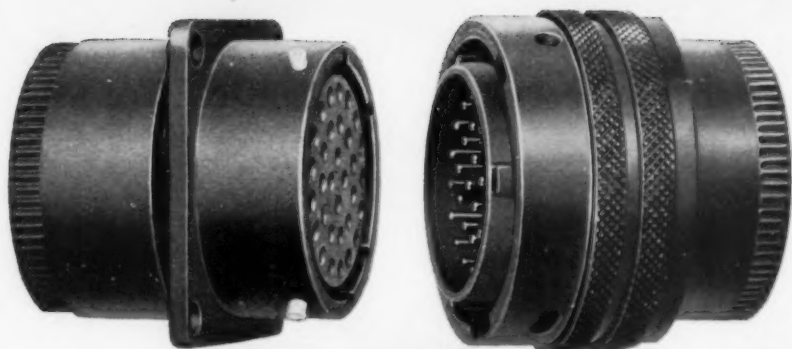
SOLA

An Affiliate of
Basic Products Corporation

SOLA-BASIC PRODUCTS LTD., 377 Evans Ave., Toronto 18, Ont.

Write for Bulletin CV



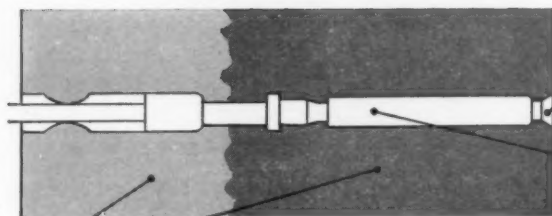


NEW

CANNON KPT/KSP MINIATURE DESIGNED TO MIL-C-26482

Quick disconnect plugs for aircraft, missiles, and all applications requiring miniature plugs. Our standard solder-pot versions, including hermetic seals, are completely interchangeable with all bayonet-lock plugs designed to MIL-C-26482!

ALSO KPT/KSP PLUGS WITH CRIMP SNAP-IN CONTACTS AND TWO SHORE INSULATOR.



Maximum lead-in chamfer for positive alignment.

MIL-C-26636 contacts (plating gold over silver)

Two shore resilient insulators molded out of two different hardness materials (polychloroprene) into a homogenous piece. The rear portion of the insulator is the softer in order that the conductors can be sealed properly, and the front portion is the harder to retain the snap-in contacts. The two shore insulator insures a continuous moisture and pressure

seal from front to back to provide superior electrical performance at high altitudes. This method of sealing and contact retention offers the industry a most reliable crimp series meeting the requirements of MIL-C-26482. Write for catalog KPT/KSP-1 to:

CANNON ELECTRIC CANADA LIMITED 160 Bartley Drive, Toronto 16, Ontario
MONTREAL: Montreal Airport, Dorval, Quebec • OTTAWA: 1168 Edgeland Place 6104

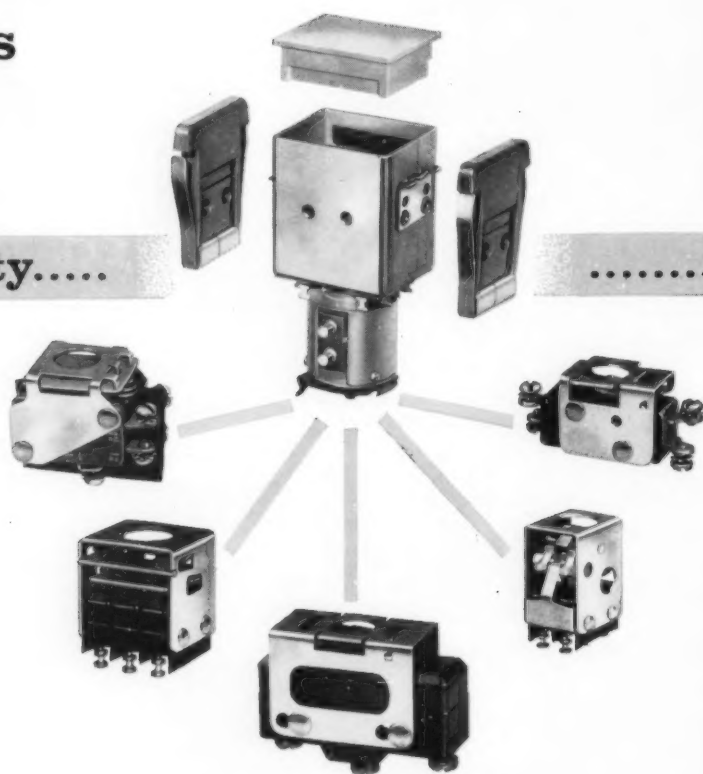


CANNON PLUGS

For further information mark No. 23 on Readers' Service Card

MICRO SWITCH
Modular
Lighted
Push-Button
Switches

Reliability.....

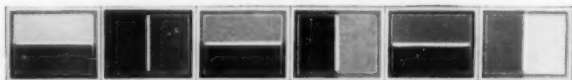




MICRO SWITCH Precision Switches

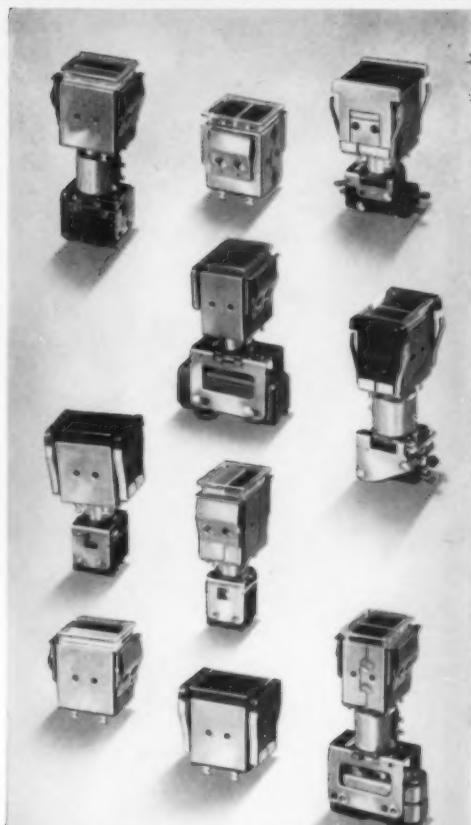
Modular Customizing...

Give your control panel a touch of tomorrow in appearance, the assurance of MICRO SWITCH reliability, and the customizing that will precisely fit your control and display functions. These Series 2 lighted push-button switches perform *both* control and indicator jobs which saves panel space on computers, graphic flow panels, electronic data-processing equipment and many other installations. They simply snap together to fit your styling requirements, then snap into slots in the mounting panel—all without tools.



Complete design freedom... units serve as remote indicators only or indicator-switches

You have complete design flexibility. Select from 48 different units and 16 mounting barriers differing in size and color. Forty different color display screens include lateral and longitudinal color divisions. Indicators and operator-indicators are available with 2 or 4 lamps and light output of lamps may be colored by choice of 4 different color filters. You may choose operator-indicator switch units or indicator units only. These modular units meet the very latest requirements for panel design in the field of Human Engineering.



.....and a touch of tomorrow

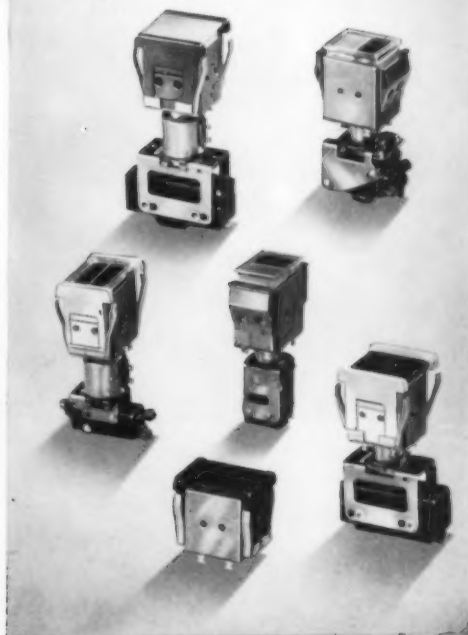
Reliability... from the best in basic switches

The last word in the reliability of your control panel depends on the basic switches used. You can be sure of that reliability with MICRO SWITCH units, and you can choose from eight different series of basic switches to fit your requirements exactly. These include switches for low-energy circuits, for handling D.C. loads up to 10 amperes, 125 volts, and for direct control of A.C. motors of up to two h.p. Alternate-action units, momentary-contact units and others for the control of multiple circuits are also available.

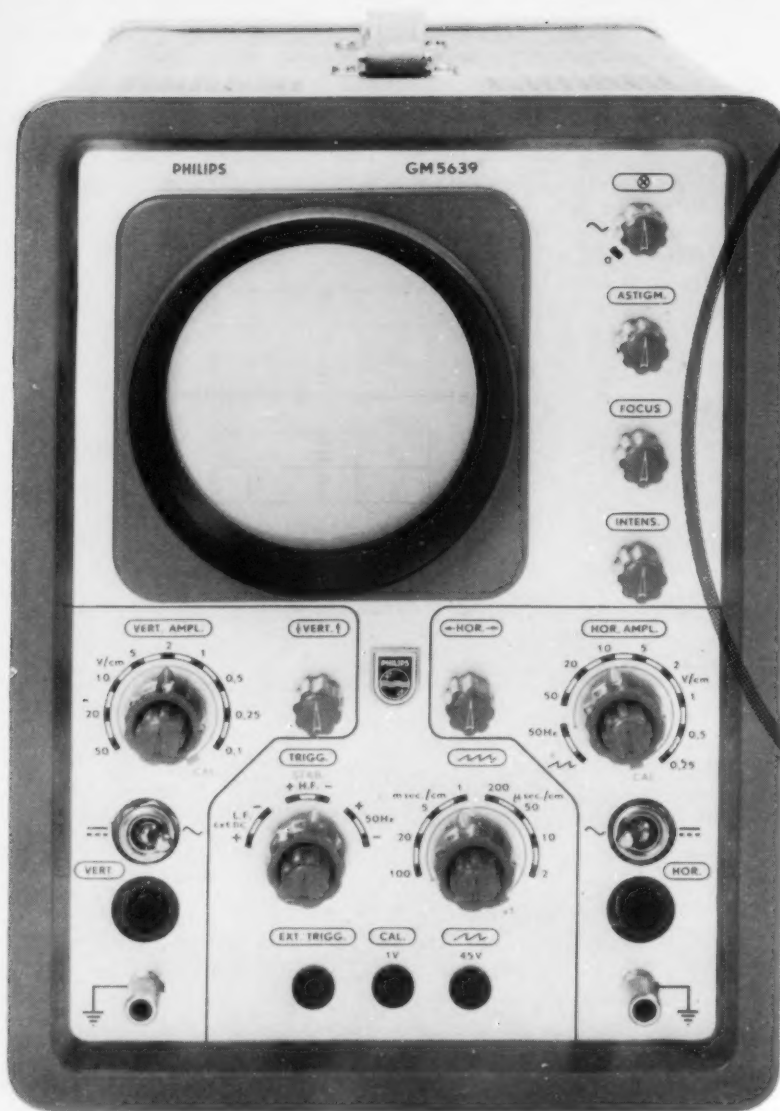
For further information, call your nearest Honeywell Office or write Honeywell Controls Limited, *Precision Components Division*, Toronto 17, Ontario.



Honeywell
MICRO SWITCH Precision Switches



For further information mark No. 66 on Readers' Service Card



X-Y oscilloscope

GM 5639

PHILIPS *electronic measuring*

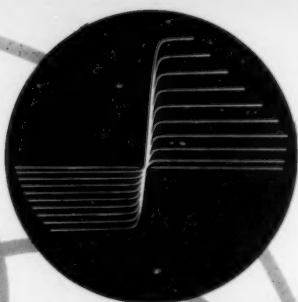
Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

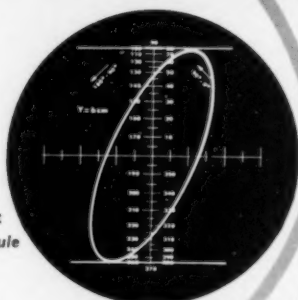
Philips Electronics Industries Ltd.,

116 Vanderhoof Ave., Toronto 17, Ont. - Montreal: 8525 Decarie Blvd.

$I_C - V_C$ curves
of a transistor



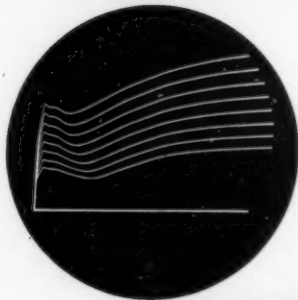
Phase measurement
with special graticule



Comparison of
3 frequencies



$I_a - V_a$ curves
of a tetrode



with exactly identical amplifiers

- The amplifiers of type GM 5639 have a relative phase shift of less than 2° for frequencies up to 1 Mc/s.
- Phase balance can be obtained at any frequency within the bandwidth.

Due to these features curve tracing without any distortion as well as accurate phase measurements can be carried out.

The time base with its sensitive and stable triggering permits of the oscilloscope also being used as a general purpose instrument.

Thus it is suitable for a wide range of applications in industry and research, especially in semiconductor and power-current techniques.

Characteristic Features

Both amplifiers

- Bandwidth : 0-1 Mc/s
- Sensitivity : Y-amplifier 100 mV/cm, X-amplifier 200 mV/cm
- Attenuation : up to 50 V/cm adjustable in 9 calibrated steps (accuracy $\pm 3\%$) and continuous 1:3
- Relative phase shift less than 2° for frequencies up to 1 Mc/s.

Time base

- Sweep speeds : 2 μ s/cm - 100 ms/cm adjustable in 8 calibrated steps (accuracy $\pm 5\%$) or continuously up to 600 ms/cm.
- Triggering facilities: internal or from an external source for pulse repetition frequencies up to 1 Mc/s.
- Adjustable trigger stability.

C.R.T.

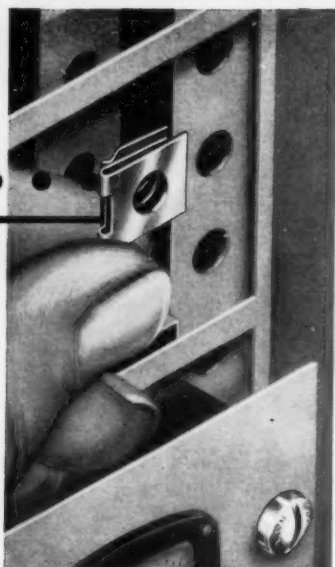
- 10 cm flat-faced tube with 2 kV acceleration voltage.
- Different graticules for curve tracing and phase measurements are supplied.

instruments: quality tools for industry and research



For further information mark No. 44 on Readers' Service Card

NEW...



clip-on
receptacle cuts
1/4 turn fastener
installation
time by 86%

for LION 1/4 turn FASTENERS

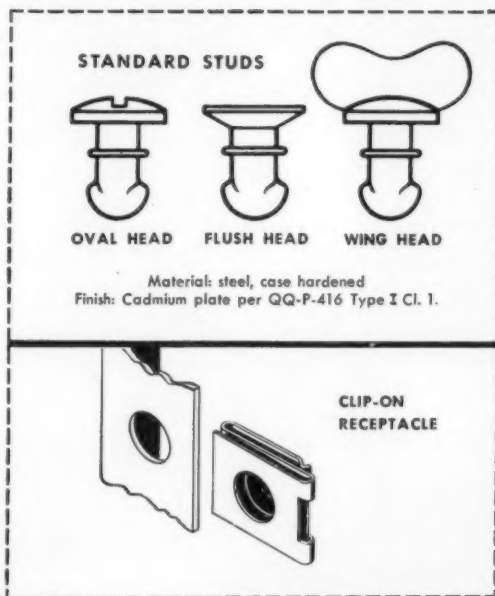
Riveting and welding are eliminated by the new, time-saving clip-on receptacle that just slips over a hole in your door frame and locks itself in place.

The Lion stud is as easily installed. Slipped through a hole in the panel or door, it is captivated by a split ring retainer. Both the stud and receptacle have a generous "float" to tolerate misalignment of parts.

Operation is fast—1/4 turn to lock, 1/4 turn to unlock.

FREE!

For complete information on this and other fasteners, send for your free copy of Southco Fastener Handbook. Write to your nearest distributor listed below.



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FASTENING DEVICES
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CANADIAN ELECTRONICS ENGINEERING APRIL 1961

PHILIPS

REFERENCE BULLETIN No. 8



Philips Special Quality Pentode • Philips Special Quality Double Triode for 10,000 hours of guaranteed service

Long, dependable service with a 10,000 hour guarantee is available with two Philips ruggedized special quality tube types E188CC/7308 and E186F/7737. Both shock and vibration resistant, these two types feature very low microphony and noise.

Designed for use in mobile equipment, control equipment, transmitters and studio equipment, the Philips

E188CC/7308 and E186F/7737 are recommended as improved replacements offering better microphony and noise properties than types 6922/E88CC and 6688/E180F. The Philips E188CC/7308 is an improved replacement for type 6922/E88CC at the same price. The Philips E186F/7737 is an improved replacement for type 6688/E180F.

E186F/7737

Broadband amplifier pentode

HEATING

Indirect by A.C. or D.C.; parallel supply.

Heater voltage	V_f	=	6.3 V
Heater current	I_f	=	320 mA

TYPICAL CHARACTERISTICS AND OPERATION¹

	A	B
Anode supply voltage	$V_{ba} = 190$	180 V
Suppressor-grid voltage	$V_{g3} = 0$	0 V
Screen-grid supply voltage	$V_{bg2} = 160$	150 V
Control-grid supply voltage	$V_{bg1} = +9$	0 V
Cathode resistor	$R_k = 630$	100 Ω
Anode current	$I_a = 13$	11.5 mA
Screen-grid current	$I_{g2} = 3.3$	2.9 mA
Mutual Conductance	$S = 16.5$	15.9 mA/V
Amplification factor of G^2 with respect to G^1	$\mu_{g2g1} = 53$	
Internal resistance	$R_i = 90$	k Ω

1) Operation of the tube under the conditions as given in column A is recommended because of the small spread in characteristics.

2) Life test conditions are:
 $V_f = 6.3$ V, $V_{ba} = 190$ V, $V_{g3} = 0$ V, $V_{bg2} = 160$ V, $V_{bg1} = +9$ V, $R_k = 630 \Omega$, $V_{bf} = 70$ V (cathode negative)
 Life expectancy 10,000 hrs.

E188CC/7308

For use as cascade amplifier or
cathode follower in RF and AF circuits

HEATER CURRENT	I	II	III
Heater voltage	$V_f = 6.3$		V
Heater current	$I_f = 335$	318-352	318-352 mA
TYPICAL CHARACTERISTICS			
Anode supply voltage	$V_{ba} = 100$		V ¹⁾
Control grid supply voltage	$V_{bg} = +9$		V ¹⁾
Cathode bias resistor	$R_k = 680$		Ω ¹⁾
Anode current	$I_a = 15$	14.2-15.8	13.5 mA
Mutual conductance	$S = 12.5$	10.5-14.5	9.0 mA/V
Amplification factor	$\mu = 33$		
Equivalent noise resistance at 45 Mc/s	$R_{eq} = 250$		Ω
Noise factor at 200 Mc/s F	$F = 4.6$		dB ²⁾
Input damping at 100 Mc/s	$r_g = 3$		k Ω
Anode supply voltage	$V_{ba} = 90$		V
Control grid supply voltage	$V_{bg} = 0$		V
Cathode bias resistor	$R_k = 120$		Ω
Anode current	$I_a = 12$		mA
Mutual conductance	$S = 11.5$		mA/V
Anode voltage	$V_a = 100$		V
Control grid voltage	$V_g = -5.5$		V
Anode resistor	$R_a = 1$		M Ω
Anode current	$I_a =$	< 20	μ A
Anode supply voltage	$V_{ba} = 100$		V
Control grid supply voltage	$V_{bg} = +9$		V
Cathode bias resistor	$R_k = 680$		Ω
Control grid resistor	$R_g = 0.1$		M Ω
Control grid current	$-I_g =$	< 0.1	1 μ A

1) V_g hum is the hum voltage referred to the grid. Measured with a fully screened tubeholder and straight response curve of the filter; frequency of the heater voltage = 50 c/s \pm 3 percent of voltage 500 c/s. Centre tapping of the heater supply transformer grounded.

PHILIPS



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6-12

BUSINESS **N**EWSPAPERS

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Tung-Sol exciter lamps deliver the photon energy to *Westrex* phototransmission equipment

Westrex phototransmission system, Pressfax, works at such high speeds that it can flash the entire content of a page twice this size — pictures and all — thousands of miles in minutes via telephone or radio links. Newspapers both here and abroad are making use of facsimile transmission and receiving equipment for simultaneous publication in several locations with copy and photographs transmitted from a central editorial office.

Photon energy for Pressfax is delivered by specially designed Tung-Sol high current exciter lamps. To guarantee uninterrupted operation, Tung-Sol developed a highly rugged unit containing a reinforced filament that withstands the shock associated with the traveling optical carriage. In addition, Tung-Sol eliminated the problem of contact resistance variation in the lamp socket by developing a heavy screw terminal for the center contact. All lamps are pre-focused by Tung-Sol so that Westrex customers can replace exciter lamps without requiring a service expert.

As Westrex summed it up: "The ruggedized lamps developed for us by Tung-Sol have met all of our expectations".

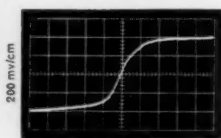
Tung-Sol's long and outstanding background in the design, development and production of low voltage lamps is readily available to you. With more than half a century of lamp making experience behind Tung-Sol, you can be sure that your lamp needs, no matter how exacting, will be met exactly. Like all Tung-Sol components — including tubes, semiconductors and flashers — Tung-Sol instrument lamps are the product of the highest manufacturing standards and quality assurance practices which have made Tung-Sol the name synonymous with the finest in componentry. Tung-Sol Electric Inc., Newark 4, N. J. TWX: NK 193

Technical assistance available through Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ont.



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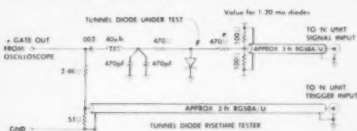
Switching Time of a Tunnel Diode ...with a Type N Unit



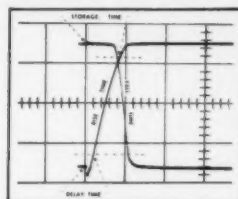
Typical waveform of gallium arsenide tunnel diode.

An easy way to test tunnel (ESAKI) diodes with nanosecond switching speeds. In this typical application the oscilloscope provides both a pretrigger for the Type N Unit and a delayed current-ramp source for the tunnel diode.

Other pulse-sampling applications requiring only the oscilloscope and Type N Unit include those wherein a repetitive signal has a $\frac{1}{2}$ to 2 volt, 45 to 200 nanosecond pretrigger, or a repetition rate from 10 to 50 megacycles.



High-Frequency Characteristics of a Transistor ...with a Type R Unit



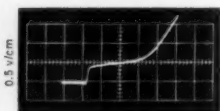
Calibrated vertical display in mA/cm of collector current.

A Tektronix Type R Transistor-Risetime Unit enables you to trigger the oscilloscope sweep either on the start of a test pulse or on both the start and finish—to display delay, rise, storage, and fall times simultaneously.

Risetime of the pulse supplied by the Type R Unit is less than 5 nanoseconds (amplitude 0.02 to 10 volts across 50 ohms, positive or negative), but overall risetime depends partially upon your Tektronix Oscilloscope. For example, typically 12 nsec—with Types 541A, 543, 545A, 555, 581, 585; 14 nsec—with Type 551; 23 nsec—with Types 531A, 533, 535A; 31 nsec—with Type 536; 70 nsec—with Type 532.

Evaluating Semiconductor Devices? ...then you must know about these 4 Tektronix Plug-In Units for any Tektronix Oscilloscope that accepts Letter-Series Plug-Ins

Waveform Analysis of a Fast Diode ...with a Type S Unit

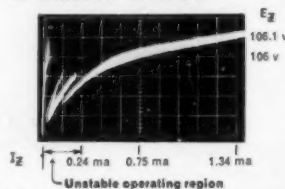


Typical display of diode reverse-recovery characteristics—with forward current at 20 ma and reverse current at 0.1 ma.

A Tektronix Type S Diode-Recovery Unit* enables you to display and measure both forward and reverse switching characteristics of semiconductor diodes. You can determine effective lifetimes to 2 nanoseconds, stored charge to 10 picocoulombs, junction capacitance to 2 picofarads, and base resistance to 0.25 ohm. Parameters measured from the curves can be used to predict the behavior of many diodes in many circuits, as well as compare diodes for performance in a particular circuit.

*Overall risetime depends partially upon your Tektronix oscilloscope—typically the same as listed with the Type R Unit.

E/I Display of a Zener Diode ...with a Type Z Unit



A Tektronix Type Z Differential-Comparator Unit provides an equivalent vertical scale length up to ± 2000 centimeters at 50 mv/cm, enabling you to accurately resolve incremental voltage or current changes in semiconductor circuits.

With Zener diodes, for example, you can display Zener voltage as a function of current or temperature. You can clearly show several important Zener diode instabilities, including white noise and microplasmas (multiple-breakdown phenomena at low junction currents).

The waveform illustrates instabilities of a $\frac{1}{4}$ watt Zener diode. With Zener voltage of 106 v at 0.75 ma and Zener impedance (calculated) of 170 Ω over the current range of 0.75 to 1.34 ma, the microplasmas shown indicate that this Zener diode should not be operated below 0.24 ma.

Type S Diode-Recovery Unit	\$250
Type R Transistor-Risetime Unit	300
Type N Pulse-Sampling Unit	600
Type Z Differential-Comparator Unit.	525

(prices f.o.b. factory)



For a demonstration of any of these 4 plug-in units in your own work with semiconductor devices, call your Tektronix Field Engineer. Ask him for the free 32-page booklet—which lists complete specifications and performance details of all 16 "letter-series" plug-ins for Tektronix Oscilloscopes.

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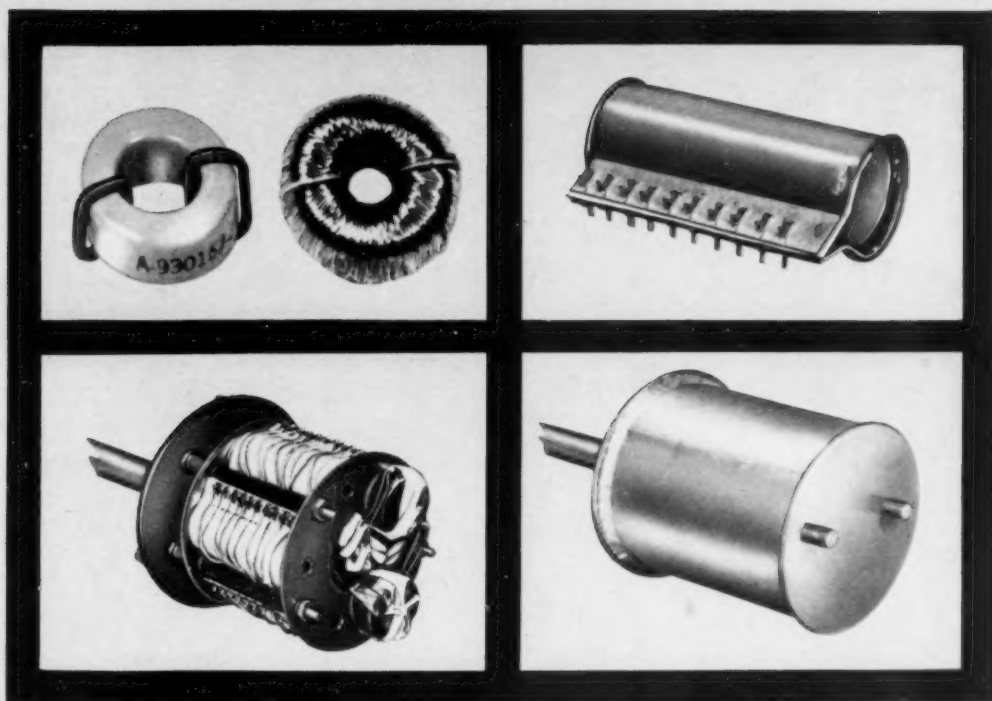
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a case for type 58 loading coils

Now AUTOMATIC ELECTRIC is manufacturing type 58 loading coils and cases in Canada at competitive prices. The advantages of loading coils on cable systems are twofold. They eliminate attenuation of voice frequencies and thus tend to eliminate distortion. They decrease the size of the cable required without loss of fidelity. And there are many advantages to AUTOMATIC ELECTRIC loading coils and cases • Type 58 coils are available in two inductances—44 mh and 88 mh. They are smaller in size and lighter in weight than the previous AUTOMATIC ELECTRIC type 35A23 coils because the high permeability of the molybdenum-permalloy core means fewer wire turns are needed for a given inductance • The basic shielded unit consists of five stacked coils with precautions taken to avoid cross talk. These basic units are then stacked onto rods and bolted firmly into a rigid unit of the required size. A heavy gauge steel housing is welded on and the case is filled with nitrogen and hermetically sealed. Every possible care is taken to assure the highest quality. We feel we have the best case. For full information write Automatic Electric Sales (Canada) Limited, 185 Bartley Drive, Toronto 16, Ontario. Branches across Canada.

* Core, coil, basic unit, assembly and case of Type 58
Loading Coil Case for aerial or manhole mounting.

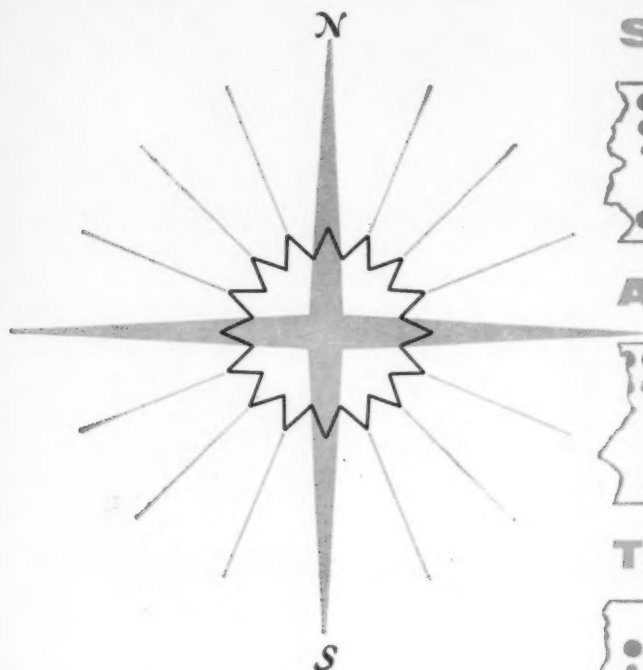
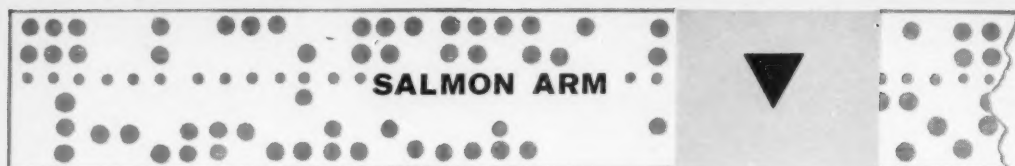
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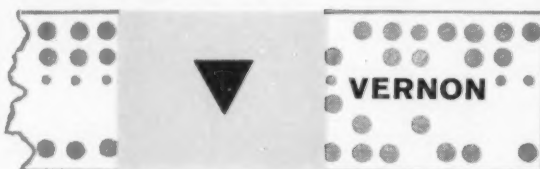
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STROWGER



AUTOMATIC



TOLL TICKETING



Okanagan Telephone Company extends SATT services to three more communities

In May, 1960 AUTOMATIC ELECTRIC completed the first installation of Strowger Automatic Toll Ticketing in Canada at Penticton, B.C. Already, the Okanagan Telephone Company has expressed their pleasure with the installation, and underlined their favourable comments with installations in three more communities. These are Kelowna, Vernon and Salmon Arm. The equipment for the installations was made in Canada by AUTOMATIC ELECTRIC.

Savings in traffic expense and increased customer satisfaction are two reasons that make SATT popular. And SATT is compatible with all other switching

equipment in Canada and the U.S. Add to these advantages the fact that the efficiency and convenience of automatic toll ticketing and direct distance dialing will bring you increased revenues, and you can see why SATT is a wise choice for your DDD application.

SATT not only meets *all* the needs of today—but is designed for economical adaptation to *all* the needs of tomorrow. If you would like full information call or write Automatic Electric Sales (Canada) Limited, 185 Bartley Drive, Toronto, Ontario. Branches across Canada.

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CANADIAN ELECTRONICS ENGINEERING APRIL 1961

Canadian broadcasting forges ahead

The Canadian broadcasting industry is currently enjoying a boom only comparable with the period following the start of television transmissions in 1952. Canadian Electronics Engineering is proud to salute its progress and future plans — and those of broadcast equipment manufacturers — in this issue.

Nine new private television stations have opened in recent months, bringing a choice of programs to millions of Canadians. In addition to many already commissioned, nearly thirty new satellite stations are in the planning stage across Canada. It is estimated that in the next two years satellites will bring television to an additional half-million Canadians and improve reception for a good many more. Radio stations across the country are increasing their power and updating their equipment. FM radio is steadily gaining ground — as demonstrated rather dramatically by the Board of Broadcast Governors' recent recommendation for approval of the application by CHFI-FM, Toronto for an increase to 210-kw. ERP. Listener interest is also being stimulated by AM/FM stereo broadcasts.

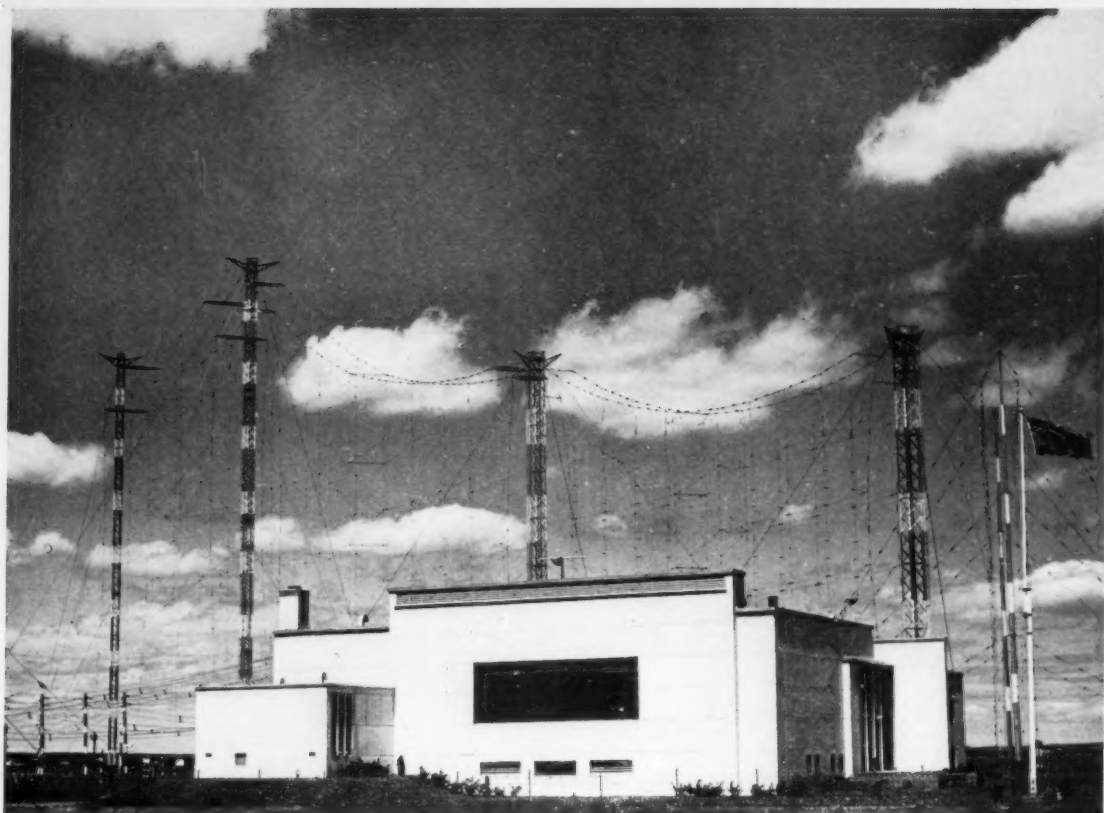
Just on the horizon lies approval of a true multiplex stereo broadcasting system and, farther in the future, the start of color television in Canada — exciting prospects for an exciting industry.

In the following pages we present a variety of features on broadcast topics. First, the results of our recent survey of Broadcasting station equipment and operating practices. Then follows a group of three articles in which D. C. Trowell, manager of CFPL Radio, London, Ontario, discusses changes in Canadian radio, particularly since the advent of television; J. R. Simpson of Technical Marketing Services outlines the evolution of packaged studio control equipment; and Glen A. Robitaille, chief engineer of CFPL Radio and Television, describes recent developments in automatic programming.

A round-up of new cameras, studio equipment, transmitters and antennas for television stations is also presented, followed by a story on Canadian Marconi's laboratory for pre-testing camera and special purpose tubes.

We hope you will enjoy reading the issue, and look forward to receiving comments.

THE EDITOR



Shortwave transmitter building and antennas at Sackville, N.B.

CBC PHOTO BY MALAK

Survey shows broadcasters' needs

HAROLD PRICE, EDITOR

Canadian Electronics Engineering has recently completed a survey in which a questionnaire was sent to all of Canada's private broadcasting stations and to CBC headquarters. Here are the results of the survey in a condensed report. Readers who want further information on particular aspects of this study are invited to write to the editor.

Canada's broadcasters are eager to provide a continually improving service to their listeners and viewers, but they rely heavily on receiving correspondingly improved service from the manufacturers of broadcast products. This is the general conclusion to be drawn from an analysis of the replies received to a questionnaire on equipment and operating practices mailed recently by CEE.

The number of broadcasting stations in Canada has considerably increased in the last few years, particularly with the addition of new main and satellite television

stations. Privately owned operations include 201 AM standard band main stations, with 3 satellites; 6 AM short-wave stations, transmitting the same program as their standard band counterparts; 31 FM stations, 24 of which transmit the same program as the corresponding AM stations; and 54 television main stations, with a total of 14 satellites. Canadian Broadcasting Corporation outlets include 28 AM standard band stations; 36 AM short-wave stations, transmitters for 26 of which are located at Sackville, N.B.; 5 FM radio stations; and 14 television main stations, with 4 satellites.

Replies to the questionnaires were received from privately owned operations covering 78 AM standard band stations (39%); 16 FM stations (52%); and 23 television stations (43%). The CBC provided information on three AM, one FM and two television stations that are typical of its over-all operation.

Here is a summary of the answers given to a wide variety of questions, reduced to statistical form. Readers who would like to obtain more detailed information are invited to write to the editor of CEE at 481 University Avenue, Toronto 2, Ontario. It should be noted, however, that the confidential nature of the survey does not permit reference to any particular station or its personnel.

Hours of operation

Seventy percent of the AM stations operate between 17 and 20 hours per day, with nearly half of these operating for 18 hours. Almost all the others are on the air around the clock, with a very small minority operating for 16 hours or less. Half of the FM stations operate between 17 and 20 hours, a quarter transmit continuously, and a quarter for less than 17 hours. None of the television stations responding provide a 24-hour service, the majority (60%) operating between 12 and 14 hours. Twenty-six percent are on the air for 15 hours or more — the longest service reported was 17 hours — and the remainder for less than 12 hours.

Age of main and standby equipment

Seventy percent of the AM main transmitters described are less than 10 years old, the majority of these having been purchased in the past few years; most of the others are at least 14 years old. Sixty percent of the AM stations have a standby transmitter and half of these were bought in 1951 or earlier. AM studio control consoles, however, are generally of more recent vintage, 70% being less than 10 years old and many of these bought in the past five years.

Half of the FM transmitters are less than 10 years old, half more than 10 years. Very few FM stations have a standby transmitter, and most of the control consoles reported by stations with separate programming were recent purchases.

Eighty percent of the television transmitters and studio control consoles were purchased between 1954 and 1958, the others being even more recent. Only two standby units were reported; these were added in 1959 and 1960.

Tube life and operating practices

A very wide variation is found in the life being obtained from RF output, high-level modulator, RF driver and modulator driver tubes. An equally wide variation is also seen in the operating personnel's opinion of what constitutes good, average or poor life! The actual average is certainly lower than one year for the larger tubes and two years for the smaller ones — a level that some manufacturers would consider reasonable.

One fact that emerges very strongly is that the older tube types such as the 806, 810 and 828 normally have a much longer life than some of the newer types with less distortion and which occupy a smaller space. Detailed information can be derived from the returns if requested by tube manufacturers or suppliers.

Of the stations operating less than 24 hours per day, 75% shut the large tube filaments off at night, but five of these leave them switched on during the winter months. These latter stations are not all located in northerly latitudes, in fact one is in southern Ontario. Two stations mentioned leaving rectifier tube filaments on at night even though their other large transmitter tubes are switched off. Of the stations that leave the large tube filaments on at night, only one does this at reduced voltage. It is not possible to derive a correlation between operating practices in this regard and the tube life obtained.

Equipment replacement and addition

Station managers were asked what plans they have for replacement or addition of major equipment during the next year and during the next five years. Many replies from AM, FM and TV stations refer to proposed power increases, involving replacement or extension of transmitting equipment. Other stations are planning additional studio facilities and will be making a wide range of purchases. Among other items mentioned frequently are:

Radio: tape recorders, both studio and portable; turn-

tables; special amplifiers; control room equipment; remote mobile equipment; automatic tape control and more automation generally; line voltage regulators; satellite and standby transmitters.

Television: cameras, audio consoles; video switching equipment; video tape recorders; color TV capability.

Suggestions for equipment designers

Another question asked: "What equipment would you like to see available that is not on the market?" Listed below is a selection of the verbatim replies. If any manufacturer or supplier recognizes his own product line in these descriptions, he's missing a sales prospect!

D.O.T. type-approved wireless microphone.

Broadcast quality RF equipment for outside broadcast pickups.

Reliable portable tape recorder of studio quality.

A small studio console.

Combined modulation and frequency monitor for AM.

Cheaper simple remote transmitter controls.

450-Mc studio/transmitter link equipment of good enough quality for FM broadcasting or multiplex.

More automatic and reliable spot tape machines.

Spot tape machine with variable echo.

Single-input transistorized microphone preamplifier.

Tape transports to feed main amplifiers.

Small transistorized remote equipment with two or three inputs that could be installed in churches and other public buildings.

Console for operator/announcer with at least four turntable inputs, three tape inputs, network and telephone, in addition to microphone and remote line.

Low-priced unilevel specially for recorder connectors.

Reliable high-quality tape cartridge machine.

Cheaper standby equipment.

Reasonably-priced accurate frequency measuring instrument to check monitoring equipment.

A good tester for high-voltage gas rectifiers.

Tape leader in a variety of colors.

Larger mixing consoles.

Stereo multiplex equipment.

Service received from suppliers

Asked what service rendered by Canadian suppliers is of the greatest assistance, most broadcasters replied: "Fast response to emergency calls for replacement components." Some station personnel, however, consider that the service they receive in this area from some suppliers is very poor. Other services mentioned in answer to this product included: technical literature, especially new product descriptions and product application notes; regular personal calls from sales engineers; "in-station" demonstrations of new equipment; and availability of certain manufacturers' new items on a trial basis.

Other types of service that it is suggested are not now available include: modifications to existing equipment to keep it up to date; an economical annual tower service; a "more realistic" tube guarantee; more information on testing and operating procedures, with interchange of information between different users of the same equipment; better stocks of replacement components in Western Canada; and handling of warranty problems on non-Canadian products by the Canadian representative to avoid customs difficulties and delays.

Canadian broadcast products

Comments on Canadian-developed broadcast products ranged all the way from "Are there any?" (it looks like that technical literature really is needed!), to "Generally excellent — wish there were more."

END



Radio must meet the challenge of listeners' changing needs

D. C. TROWELL*

In the past few years radio has undergone a major change. It has become a constant companion for most people and is associated with their daily activities. Radio station personnel must adapt to the new techniques to keep up with listener needs.

Radio has undergone a number of changes since the introduction of television, and a lusty new form of lively, modern radio has emerged. It's being produced in various ways, with various accents on different parts of its structure so that with some stations, the music appears to be the pace-setter; with others, it's the news; in others, stunts and gimmicks play the lead. In some stations you find all these things in varying degrees.

Essentially, today's radio, regardless of its format, is a continuous work companion for most of the people, most of the time. Radio has emerged as constant minute-by-minute, hour-by-hour, day-by-day chronicle of life-in-the-community, in many cases (and the number is increasing), overlaid on a carrier of popular music. There are various forms which it takes and various sounds which emerge, but modern radio tries to be some or all of these things: consistently lively, interesting, warm, friendly, comfortable, alert, exciting, useful, strongly local. It's costing more, working harder and doing a better job than ever before. Mind you, there are as many variations in this theme as there are stations, since each station builds for local needs and individual acceptance.

The great thing about it all is that today's radio is on the move. It isn't sitting still any longer. It isn't wandering aimlessly around any more trying to figure out just what its job is. The reason it isn't doing that anymore is because

radio finally went to the people. It went to the people and found out what they wanted.

One of the most interesting studies which established the fact that people wanted radio to be this useful, constant companion was the one conducted in 1956 by the Bureau of Applied Social Research at Columbia University. The study showed that the modern radio audience listens to stations rather than programs. Listeners tend to set the radio dial and leave it there. Behind the selection of the station they wanted, the study revealed that people turned to the station which suited them best, the station with which they could most closely identify. Some people wanted certain things more than others did; some people wanted a blend of all of them; some wanted concentrated parts. The net result was that radio stations were able to develop along those particular lines.

Where there's a high diversity of radio station listening, such as in large metropolitan areas, there is apt to be a much higher degree of specialization. Conversely, in a smaller town with fewer stations and thus a broader spectrum of the public to serve, then you'll probably find more conservative approaches, more middle-of-the-road blending of all those ingredients. One thing you will find though, in most parts of North America today, the most successful radio stations, the ones attracting the largest audiences, are the strongly local radio stations programming locally to the people within the community. They're very deeply service-oriented. This involves them in the community and, in turn, the community involves itself in the station or stations—a vital factor in audience building and holding.

Management in radio had become ingrown. We thought of ourselves only as we had been or as we were traditionally supposed to be, and we didn't think often enough and hard enough about whether we were providing something of intrinsic value, something that people wanted.

Many people already in radio felt they had the answers to what people wanted. These were based on their experience and knowledge and background. But what they

*Manager, CFPL Radio, London, Ontario.

were really doing was simply trying to improve a product that had been ground out for years and years and which actually, in terms of people once again, was as out of date as button shoes. We thought of ourselves as radio with a capital R in the traditional program form. We didn't know, or rather we didn't realize that most people didn't want programs from radio as in the old days. We were reluctant to admit that television was now the program entertainer for most people and we had yet to discover that we had an exciting new role to fill in the field of communication with certain obvious things which we could provide, which people wanted to have and which they would take from radio if radio would only give them.

May I come back to this point that to most of the people, most of the time, radio is a constant work companion. More than that, with many people, it also fills the basic need for warmth shared by every human being. It keeps him alive to what's going on around him. It makes the day-to-day tedium of housekeeping or a repetitive job something a little more pleasant. It makes life just a little bit more exciting, perhaps, and puts people in touch with the world.

I'm not suggesting that radio is the only thing that can do this, because it isn't and never will be. However, the fact remains that nearly everybody has a radio today; radio sales have gone up tremendously.

Engineering developments during and after World War II made it possible to build smaller and cheaper radios. When this happened, radio became a very personal thing. People didn't have to go to radio anymore; radio came to them, in their automobiles, factories, offices, warehouses, bedrooms and kitchens. Radio started reaching people as individuals rather than families and groups, as it used to do. Radio became the world's most "everywhere" medium, and while the slogan "wherever you go, there's radio" may sound trite, it's true. This meant a great diffusion of listening which radio had to take into consideration in determining how to serve this mass of surging, rolling audience.

While people could listen to radio in all sorts of places for longer periods of time, most of them didn't really have the time or inclination to sit down and listen to hour, or half-hour long programs as such. They wanted their news in capsule form, frequently, regularly and updated. They wanted to be able to count on the news at certain times; thus the hourly newscasts. If radio was to keep pace and reach people on the run, it would have to provide its music, its entertainment, its service features in a concise form.

To illustrate how radio's audience is constructed we frequently use the analogy of the street car. It runs all day and it runs all night. Some people get on at one end, ride all the way to the other. Some people get on and ride part of the way. Many others get on and get off, then get on again at different intervals. Even though there may be only 100 seats on the car, with the fare being a dime, by the time the car has made the entire run, there are a whole lot more than 100 dimes in the cash box.

It's the same thing with radio. Some listeners start and stop; others use it briefly and infrequently. They all add up so that within a month 98% of all the people use radio some time or other.

Station organization must adapt to new techniques

How does all this affect the organization of people within a radio station?

With this new form of stream broadcasting, this 24-hour utility, it is necessary to establish a new form of organization to make it work. Today, there is much closer management participation in all phases of a station's operation, and there is closer liaison among the divisions.

There are certain elements which radio station management generally attempts to mold into a pattern for their listeners. They are news, public service, service information, opinion, advertising, music, production, personality, promotion-exploitation. The responsibility for developing each of these areas as individual parts falls to different people in the organization. For example:

1. Control of physical assets of a station rest with Engineering.

2. Control of the product, the program, is the responsibility of Programming.

3. Developing a new form of advertising story and marketing method so that advertisers could use radio more effectively, more efficiently and more realistically is the responsibility of Sales.

4. Promotion-exploitation has to get out and keep people acquainted and aware of what is going on at the station.

5. Research, in turn, must report back on how people like it.

All parts of the station operation interlock; it requires detailed co-ordination. Taking each of these parts again, but in a different order, let's look at it this way:

The Product (program) has to fill a basic need for warmth in humans. This means that Programming has to select talent who can communicate with people that way. They must also be bright and cheerful.

The product has to provide people with a heightened sense of living, combined with a certain familiarity. This is where popular music comes into the act.

The station must be aware of all the things people want to know. I don't mean just the basic information such as time, weather and news. These are important enough to have their own categories. People want to know what's going on in town, what's on television, what's showing at the movies, where the fish are biting, how to solve personal problems. These end up in modern radio as brief, concise items.

In terms of news, radio is in a strong position to provide local news service which other media, at the moment, cannot offer. It's largely because of engineering developments that radio is in this enviable position. Engineering made it possible to do all sorts of things which no one else is able to do. Mobile news units equipped with short-wave radio, portable tape recorders, fleets of cars equipped with radio telephones, helicopters, airplanes, monitor radios in newsrooms, beeper phones, and other things are turning radio into an exciting form of electronic journalism.

We have to exploit our best points. There's no point having all this going on if people don't know about it. That's where the Promotion people come in. They have to back and fill in terms of all our competition—not just radio competition, but in terms of the competition for people's time and interest from television, print, movies, sports and social activities.

We have to merchandise to people and when we have them coming to us, our Research people have to study, analyze, interpret, modify so we can sell it all over again to advertisers.

That brings us to Sales. They have to learn about the new radio and tie it to the marketing problems of advertisers. This means innovations in rate structure, innovations in advertising campaigns, less of the old style one-a-day-brand of time buying and more of the saturation technique to use all of radio.

From here on we will have to know more about our audience and its composition: attentiveness, sex-age breakdown, socio-economic breakdown. This will be used by both Sales and Programming.

Finally, the technological part. We have to make sure

we are working with transmitters at top permissible power and highest possible compression, not just for our own satisfaction, but because all sorts of signal interference has grown up around us in the expanding postwar years. All kinds of electrical equipment found in every home (especially some TV sets) create interference with AM signals. We also have in our Canadian frequencies a public resource which we ought to protect from foreign encroachment to the best of our ability.

The demand from Engineering is first-class quality all the way. That includes records, microphones, turntables, pickups, tapes, etc. All of this has to be loud and clear on a 4-in. or smaller speaker. There are remotes, short wave, FM link, and line quality to think about. And Engineering has to do all this so that everything works every minute of every hour of every day.

Where next and what next?

Before we try to figure out where we are going, we should remember what we are. We're a medium of communication.

All of us in radio have to learn to think as engineers do. We have to think in pure terms—in basics and fundamentals. We must be prepared to cut loose from tradition and break the ties that bind our minds. Radio is communication with fantastic possibilities and a great role exists for the creative engineer and technician—the man who can use pure science and turn it to applied science and technological developments. The electronic means already exists for moving material, storing it, repeating it and translating it. It's in the application of scientifically designed, developed and produced equipment to facilitate and expedite the material of the mind and its movement from man to man which holds such promise.

The biggest problem of all is ourselves. Are we a match for ourselves? Can we cope with the new problems? I think we can.

If the communications business has a responsibility to help people understand an increasingly complex world, then individuals within the business have a treble responsibility: to people, to our business and to ourselves. We must first develop communication among ourselves before we can adequately carry out our giant job.

We have to understand each other's language. That means the engineers and technicians have to be understood by the other people who use or can use the products of science—the writers, artists, administrators and salesmen. All of these must know as much as is reasonable about the technical devices and means at their disposal.

Likewise, technicians and engineers must get together with the others to find out what they want to do.

It has to be a two-way exchange here. If we go out and research the people to find out what they would like to use or get from radio and determine how they would like to get it in terms of its production form, there may still be a problem of how to get it to them at its most favorable time. That means we have to know what we can do in terms of technical advancements and equipment.

In the future many stations may be faced with the problem of providing more hours of programming, while keeping staff and operating costs to a minimum. The trend has already started with multiplex FM or AM-FM operation. What an exciting challenge this will be.

The answer, of course, lies in technological areas—in machinery to remove the drudgery and degradation from human endeavour, leaving man's mind to be used to better advantage.

At CFPL we have been able to take a step in this direction. We have developed equipment which permits automatically controlled and directed all-night operation using stored instructions on a punched paper tape. This is described in detail by G. A. Robitaille later in this issue.

We hope we can apply some of the experiences and lessons we learn to other marginal areas of our operation. Then we can devote the mental energy of our people, their efforts and our money to more valuable things in human terms than turning switches, cueing records and perhaps even sitting idle for a large portion of every hour of duty. There is no intention on our part to let anything suffer in terms of either our service to people or our relationships with our staff.

Changes are going to take place in radio, not just for the sake of change, but to improve. Successful changes will be based on research of people to find out what people want. Then, it's up to the imagination of writers and producers, coupled with the imagination and skills of science and engineering to produce the innovations. To do this, we're going to have to learn to speak the same language without any question. When we can do that, we will be in a position to develop tomorrow's radio based on not only the lessons and experiences of the past and the present, but on a plan of change to meet the challenge offered by needs and problems of the communication of man to man. We're going to need stability without inflexibility so that, while we will form strong images, we're always in a position to meet the demands created by changing times and needs.

END

TV receiver radiation interferes with AM reception

The Canadian Association of Broadcasters at their annual meeting in Vancouver, March 14, were told that television receiver horizontal oscillator radiation has a serious degrading effect on broadcast radio reception.

In presenting an interim report to the C.A.B., Mr. Herbert A. Hoyles, Consulting Broadcast Engineer, said the Hoyles, Niblock and Associates study is making good progress on an investigation of sweep radiation interference for the Association.

He advised that "although the station power increases achieved through the provision of the North American Regional Broadcasting Agreement of 1950, offer improvement over the interference effect of random noise, they offer inadequate relief from the co-

channel interference as generated by the horizontal oscillator deflection circuitry of television receivers".

In outlining the seriousness of this type of interference to standard band AM broadcast reception, Mr. Hoyles further reported "in certain cases, the measured interference from television receivers, as found in the home environment, exceeds the interference-free signal level for broadcast stations as established through the North American Regional Broadcasting Agreement".

At the conclusion of the investigation the Hoyles, Niblock report will serve to assist the broadcaster, Department of Transport, and manufacturer, in lowering the level of this type of interference and in the establishment of relevant regulations.



The evolution of the package

J. R. SIMPSON, MEM. I.R.E.*

The growing complexity of operating procedures in modern radio and television studios, and the need to keep operating costs at a minimum, have led to the evolution of packaged audio control consoles. This is a discussion of the main design considerations with examples of new packaged equipment.

In the preceding article in this issue, D. C. Trowell, manager of London's CFPL radio, discusses some of the changes which have taken place in radio programming since the advent of television. Radio, in Mr. Trowell's words, has become a "continuous work companion for most of the people, most of the time", a "minute-by-minute chronicle of life in the community". The increasingly sophisticated programming demanded by this type of radio, plus the pressures of rising operating costs and stiffening competition, have had some significant influences on studio equipment requirements.

In addition to the normal microphone and turntable facilities, contemporary programming requires the use of tape equipment, both reel and cartridge. Taking radio to the people involves utilization of program sources remote from the studio, as more on-location broadcasts, telephone conversations between listeners and station personnel, and other types of community programming are adopted. The increased number of program sources and the necessity of switching them rapidly have made studio facilities more and more complex, while economic pressure has reduced the permissible operating staff.

In the case of radio broadcasting, these factors have led to increased centralization of control during operation, with one man handling a wide variety of input program material on a tightly scheduled basis, and in many cases announcing as well as operating. In television broadcasting, much the same situation has always pertained, more because of the nature of television production than as a result of changing operational requirements.

Until recently, the engineering of studio facilities involved the assembly and integration of a great many different equipments, including speech input control and distribution facilities, turntables, tape machines, and so on. The interconnection and testing of all these various items was generally done on location, with the result that the control room was a potpourri of rack-mounted units, console assemblies, and separate turntable and tape units. Under these conditions, it was difficult to properly pre-engineer all the necessary cabling facilities, jackfields, etc., and many such items had to be worked into the system during actual installation. Problems were encountered due to the lack of standardization in input/output connectors, control designations, spare parts, and even basic terminology. From the operational point of view, the bits-and-pieces approach made integrated control by one operator awkward, if not impossible, since little if any human engineering could be done.

Modern studio requirements lead to packaged controls

The demand for increased flexibility and efficiency, with reduced equipment, engineering/installation, and operating costs, led to the concept of the "packaged" master control unit. Although such systems were initially designed for use in AM/FM broadcasting, the techniques were readily applicable to television, since a capacity for the control of multiple inputs by a single operator is a natural requirement of television production.

The packaged system can be properly said to have

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Figure 1. SS4000

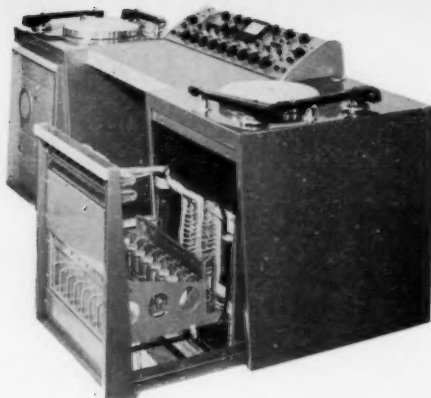


Figure 2. SS5000

"evolved", since it became immediately obvious that one design would not satisfy all requirements. While the same general types of program sources are used by all broadcast stations, the quantities of each type, and the proportion of air time during which each type is used, vary with the programming requirements of each individual station. A package designed for any given application must contain sufficient facilities to provide for 24-hour operation at a high level of efficiency, without superfluous equipment which would render the unit economically impractical. On the other hand, a certain amount of standardization must be maintained from system to system in order to achieve the manufacturing economies which make the package concept attractive in the first place.

The concept of the initial packaged master control unit was based on several broad design criteria:

(a) The unit should contain as many of the required studio facilities as practicable, and preferably all of them.

(b) It should be so organized as to permit a single operator to handle all the various program sources involved, preferably without moving from his position at the console. It should be human engineered to minimize fatigue, to permit the operator to perform an announce function as well as the selection and control of other program material, and to provide instant visual indication of program routing and status.

(c) The unit should be mechanically designed so as to provide visibility into studios and/or announce booths on all sides of the control area, rendering effective location of the unit independent of room characteristics. Weight should be distributed so as to prevent inordinate floor loading in any one spot.

(d) All components of the system should preferably be accessible from the front of the unit, so that it can be positioned against a wall if required, and so that the operator can perform any minor maintenance which may be necessary. Duplicated components should be individually maintainable without affecting system operation.

(e) Mechanical design should permit complete pre-wiring prior to shipment, and testing of the over-all system at the factory to ensure uniformity of performance characteristics and to allow an absolute guarantee of system specifications to be given. Shipment should be made in the largest practicable sections, and all inter-section connections should be made on a plug-together basis, to minimize installation time. Assembly and wiring should be sufficiently simplified to permit installation by station personnel.

These requirements are by no means mutually comple-

mentary, and a great deal of attention had to be paid to the mechanical and human engineering aspects of the packaged unit, in addition to the careful electrical design necessary to provide the high-quality performance demanded by broadcast applications. Since the facilities had to be grouped logically according to function and operational priority, all within easy reach of the operator, the equipment density was high. It was therefore necessary to utilize differences in relative position, color, shape, size, and even texture of controls, to ensure that the operator would develop and follow efficient sequential response patterns. These requirements were further complicated by aesthetic considerations, although the achievement of a high order of function in design automatically resulted in aesthetic appeal.

New control consoles utilize package concept

As examples of some of the techniques used to satisfy the criteria given above, several of the packaged systems designed and built in Canada by McCurdy Radio Industries are discussed briefly in the following paragraphs.

The first in the series of MRI packages was the SS4000, shown in figure 1. This unit, designed for the widest possible application in AM and FM broadcasting, includes facilities for the control of three turntables and two tape machines, as well as ten remote lines and six local microphones. The use of plug-in or plug-together components throughout permits additions to, or subtractions from, the standard system. Internal wiring is provided for all functions, including remote start-stop for turntables and tape machines; amplifiers, turntables or tape equipment not initially required may be added later without modification to the existing system. The package contains all the facilities for the control of two announce booths, for monitoring, cue and talkback, and control circuitry for such ancillary items as on-air lights, order-wire telephones, etc. It is equipped to process two independent channels, so that rehearsal or recording may be carried out on one channel while the other is on the air.

The unit is shipped in three sections, which are bolted together and interconnected by means of pre-engineered cables. Only the microphone and speaker lines, program lines and main power feed must be connected in the field. Installation time, which can be an appreciable element of the initial cost of studio equipment, is approximately six hours. This compares with an average of 18 man-days for field-assembled systems providing equivalent facilities.

The smaller SS5000, shown in figure 2, is an example of a packaged unit designed to meet a specific set of phys-

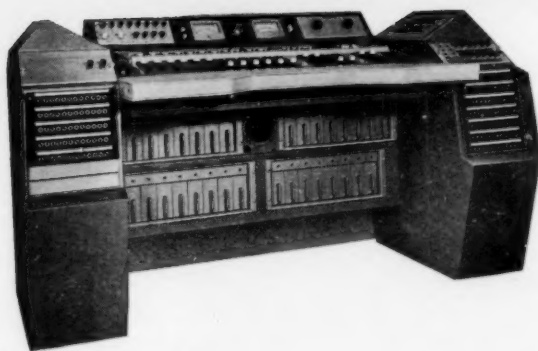


Figure 3. SS4600

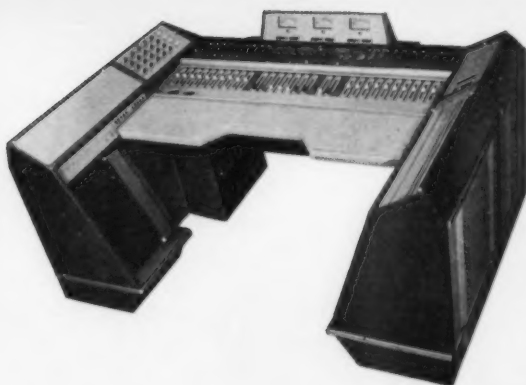


Figure 4. SS4500

ical parameters, and to perform a specific function. This unit, which provides maximum utility consistent with extreme compactness, accessibility and light weight, was designed for transportation by air into Canada's far northern areas in a single package, and for installation in minimum time (one hour average). It provides amplification, control and distribution facilities for nine microphone inputs, two turntables, six line inputs, and two external tape machines. Although it is a single-channel console, two high-level outputs are provided, as well as two auxiliary bridging outputs which permit recording of program material. Like the SS4000, the small package utilizes plug-in interchangeable amplifiers, regulated plate and filament supplies, and individual monitor amplifiers for control room, studio and announce booth areas. Access to all components is provided by sliding drawer assemblies and a hinged console front panel.

Audio control for TV stations is complex

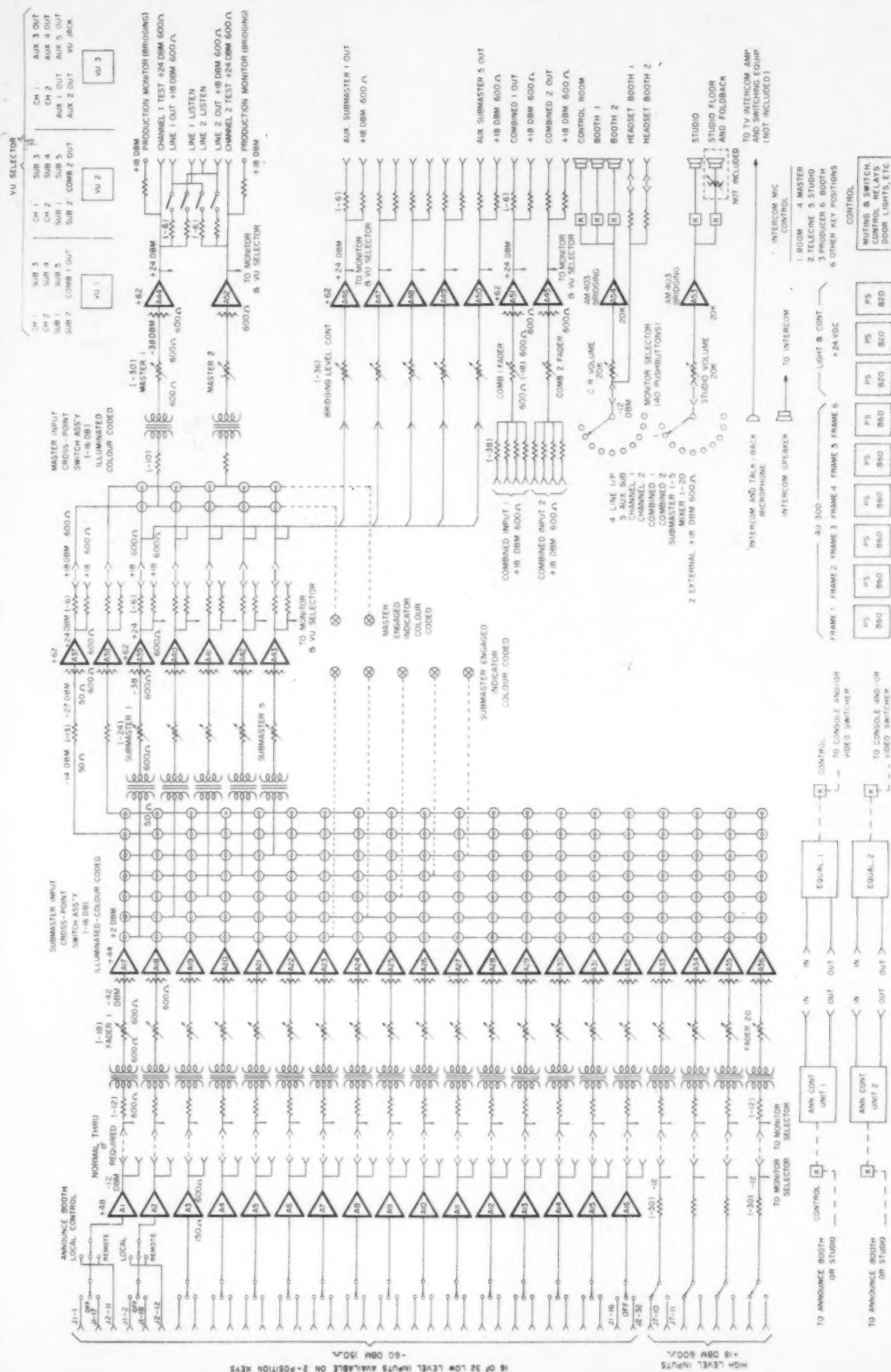
As mentioned earlier, the requirements for television audio control equipment are similar in many ways to those for equipment used in AM and FM broadcasting, except that the program sources are often more numerous and are generally less immediate to the operator. In addition to the microphone, turntable, line and tape inputs encountered in radio programming, the television facility must be capable of handling inputs from Telecine chains, video tape recorders, and other specialized equipments. Because of the scope and complexity of television production, the operator is often required to control a large number of simultaneous inputs from different sources and at varying relative levels.

The McCurdy SS4600 and SS4500 TV Audio Control Consoles, shown in figures 3 and 4, are designed to process 12 and 20 simultaneous inputs respectively. In these units, the need for integration of program sources such as turntables and tape machines is replaced by a requirement for extremely flexible mixing and switching facilities. The SS4500, for example, permits the independent selection and processing of 16 low-level and four high-level inputs at one time, from available totals of 32 and eight. All this material may be fed simultaneously to two output channels, either directly or via five sub-masters which are themselves equipped with auxiliary high-level outputs. The block diagram on page 44 (figure 5) illustrates the scope of the facilities included in the package; the use of both low- and high-level jackfields, plus cross-point switching of all sub-master and master inputs, affords the high degree of flexibility required.

Because of the complex input/output configurations encountered in television applications, extensive use has been made of color in the engineering of the TV audio control facilities. In the smaller package, color-coded pushbuttons and lights are used to identify each sub-master and master channel, so that the exact routing of each input and the status of each channel is constantly indicated to the operator. In the more complex SS4500, the selection buttons are illuminated as well as color-coded. To permit simultaneous control of more than one input or output channel, in-line slider-type faders are used; the advantages of finger-tip control, with no torque required, become increasingly apparent as the number of controlled functions increases. The location of each fader bears a specific functional relationship to its associated selector buttons and indicator lights.

Slider-type controls are also used extensively in the SS4200 AM/FM packaged systems, illustrated on page 41, installed at CJAD Montreal. This dual-channel unit is equipped to process material from five microphones, four turntables, three reel tape machines, four cartridge tape units, and any two of a maximum of 24 program lines. In addition to these facilities, the package incorporates such sophisticated features as bridge cueing which permits simultaneous cue while the program source is on the air, transfer switching circuitry for microphone filters and echo equipment, and special audition facilities independent of the cue circuitry. All the necessary equipment is contained in the console with the exception of power supplies and 30-watt monitor amplifiers, which occupy one of the racks in the background of the illustration. The remaining racks house ancillary studio equipment.

Pending the evolution of operators with four arms and/or prehensile toes, the ability of one man to announce/operate with a minimum of error has probably been exploited as far as is possible in the SS4200. Quite apart from human fallibility, the physical bulk of equipment prevents further concentration of facilities within a reasonable radius of the operator's position without sacrificing accessibility. Further development of the package concept will no doubt be based on automatic sequential programming techniques, some of which are discussed by G. A. Robitaille in the article following. The switching, control and distribution of multiple program sources, performed on a synchronized time basis by automatic equipment, will reduce the number and size of controls requiring attention, and release the operator from many of the more mechanical routines of programming. The next step in the evolution is the automatic package. END



Glen A. Robitaille, chief engineer of CFPL Radio and Television, London, Ont., has won the 1961 Col. Keith S. Rogers Memorial Engineering Award for outstanding achievement in the broadcast industry. He won the award for the development of automatic programming equipment described in his article below. Mr. Robitaille becomes the first individual to win the award twice, since it was established in 1950. He won it first in 1953 for his work the previous year as chairman of the Central Canada Broadcasters' Association technical committee. The award trophy is presented annually by the electronic equipment and tube department of Canadian General Electric Co. Ltd. Presentation is made at the annual meeting of the Canadian Association of Broadcasters. In the photograph, Mr. Robitaille is shown explaining the punched paper tape to CFPL Radio secretary Rejeanne Forget. At his elbow is the tape reader; the remaining control equipment is contained in the rack on the extreme left.



Paper tape control permits automatic programming of radio stations

An automatic programming system has been developed at radio station CFPL, London, to permit unattended operation of the station at night. It is controlled by punched paper tape to achieve maximum flexibility and reliability. This article is based on a paper delivered at the Western Association of Broadcasters' meeting, Calgary, February, 1961.

GLEN A. ROBITAILLE*

*Chief Engineer, CFPL Radio and Television, London, Ontario.

The history of automatic programming at radio station, CFPL, London, Ont., started about two years ago when the management of our station saw, in the business papers, stories and advertising concerning the use of automatic programming systems in radio stations. It was then, and still is, our opinion that automatic programming is a partial solution of an operating cost problem that is an increasingly serious factor in our operation. This is especially true in view of our desire to improve the services we provide to listeners through better programming and extended hours of both AM and FM services. Our desire to accomplish this while holding down costs has led us to automatic programming. The attraction of automatic programming is better utilization of the various skills available at a station and the hope that it will result in providing better service at a minimum increase in costs.

With this objective in mind, we searched for any commercially available system which would meet our needs without compromising the programming philosophy of our staff. Our search for such a system was not successful. Each system we found seemed to have drawbacks that would give us less flexibility in our programming, rather than more, and would cost so much that we hesitated to invest.

We did not seem to be getting anywhere until a set of circumstances prompted us to jump in with both feet. In engineering we had accumulated some good ideas for building a system to satisfy our requirements. And just at that time our all-night announcer decided to leave us.

We held a meeting to consider the feasibility of programming our radio station automatically during the night.

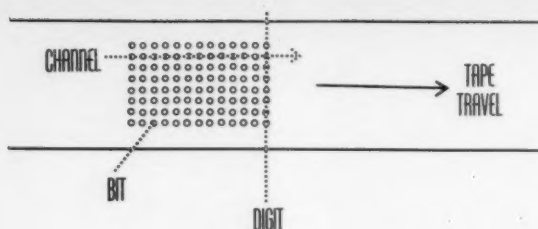


Figure 1.

If it could be done, we would not replace the all-night announcer operator.

When we left the meeting we had decided that the programming group would work toward programming the all-night show using taped material with the operating function reduced to merely starting and stopping tape machines. If and when they evolved a system that produced a satisfactory program, we in engineering guaranteed to replace the man pushing the start and stop buttons with a box of tricks. A few months and lots of meetings later, the programming format had been developed and our job started.

Basic program format is first step to automation

The basic program format was deceptively simple. It was proposed to start auto-programming at 1.03 a.m. after a live news program. It was to continue to 6.00 a.m. Since music is the vehicle for our service, it was considered first. It was empirically established that the music in this time period could be continuous. It only needed to be faded down or out for service inserts. It was also established that vocals could be faded in or out without materially affecting the service value of the program. Once this concept was established, the service inserts were considered. The pattern adopted is shown in Table I. It shows only one hour, since all hours were divided the same way under our original programming; this method has been changed.

TABLE I

00.00	News (approximately 3 minutes)
10.00	Time announcement
15.00	Weather and sports (approx. 1 min.)
20.00	Time announcement
25.00	Time announcement
30.00	News (approximately 1 minute)
35.00	Time announcement
40.00	Time announcement
45.00	Weather and sports
50.00	Time announcement
55.00	Time announcement

This works quite simply. The time announcements are the same each night so only one time tape need be made with appropriate announcements recorded in sequence. The news, weather and sports can all be on another tape and recorded in sequence so it looks as though, with two music tapes, only four machines are required. This was quite true and we did operate with four machines. It was a new news tape each night, naturally, and the music was on a dozen or more one-hour tapes which were rotated. One or two were erased and refilled with new music each week. The programming was quite satisfactory for automatic operation and for this time period.

With only this programming in mind, it was tempting

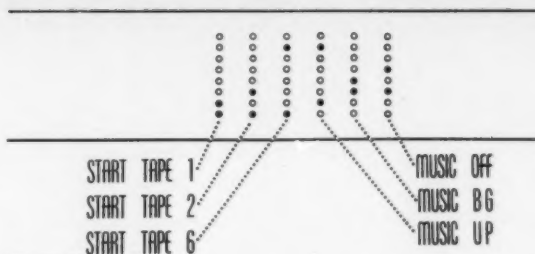


Figure 2.

to build or buy a time clock which would trip tape No. 1 with the time announcements on it at the appropriate times each hour and trip tape No. 2 with the current weather, sports and news on it, at the other appropriate times. It seemed that a clock could be purchased to do all this plus, of course, turning the music up and down at the proper times. The clock, working on a one-hour cycle, could be used to start two self-stopping tape machines at specific times within each hour. The music is continuous and needs only level control which could be accomplished through time delays, an automatic gain control (AGC) and stop pulses from the tape machines.

Clock system limits flexibility of programming

Although we don't use this system, we do use many of its components which will be described. First, note the requirements of the tape machines. They must start on a voltage pulse and run until stopped by a built-in cue system when the program material is finished. When it stops it must send out a voltage pulse to trigger the automatic gain control. The AGC must be capable of operating from any of 3 pulses: (a) one to turn the gain from full 'on' to 'off'; (b) one to turn the music gain to an intermediate level from full 'on'; (c) a third to turn the music to full 'on' from either of the foregoing levels.

Because the music fades take time, there must be time delays to synchronize the music functions and the insert tape machines. The music machine audio circuits must go through the AGC and get mixed with the audio from all the other machines. The music machines must be interconnected so that when one stops, the next starts.

The reason we did not use this clock system is because a relatively simple clock would limit the system application by requiring each hour to be the same. It would also require each night's programming to remain the same. To expand this system would require a very complex clock and extensive manipulation of cams or contacts by skilled persons if any allowance was to be made for an increase in the number of tape machines controlled or extensive daily program changes. Also, it did not appear practical to store programming information for re-use at a future date. By this I mean that it did not seem practical to store the Monday night programming information so that a single operation such as pushing a button would allow us to preset the equipment in the same manner for next Monday assuming, of course, that the same programming is required.

At this stage, a new problem arose and we were pushed again. It appears that a person sitting for five hours watching a clock and pushing buttons each five minutes gets a complex or something. Our operators were coming "unglued."

In any case, experience looking into the time clock system and awareness of other potential applications of the automatic equipment made us decide to build for

maximum flexibility, within reason, and build to satisfactorily handle any programming situation we could dream of and build fast.

Paper tape is versatile control medium

The system we designed and presently operate uses punched paper tape for information storage and will handle ten program sources in any random manner in a feed-back mode, a straight time mode or a mixture of both. The duration of the time period controlled is virtually unlimited except by the capacity of the audio tape machines. The time reference is a synchronous motor.

First, I'd like to talk about punched tape. We went to this because we think it is a good compromise between cost and storageability. Good reliable punched tape equipment is in common use. It is quite possible that punched tape equipment used for automatic programming could find additional use in your office. Indeed, it is quite probable that automatic programming tapes may be a by-product of normal traffic procedures in a radio station. I must admit that this possibility influenced our choice of equipment and its adaptation to automatic programming.

We selected 8-channel paper tape for three reasons: (a) it provides maximum flexibility for office use; (b) it allows simple codes for auto-programming; (c) its cost is only slightly higher than paper tape with fewer channels.

Fig. 1 shows a piece of 8-channel tape with the feed holes omitted. In our usage, a digit becomes a code only when holes are punched. The tape is read one digit at a time at speeds up to a maximum of 360 digits per minute. The use of 8 bits of information allows at least 256 codes by simply varying the number and position of punched holes in any digit. Our equipment is designed to use only 20 different codes so we have lots of room left. The tape handling equipment we have cost us about the same as an Ampex model 350 magnetic tape machine.

Fig. 2 shows a few of our codes which consist of two bits of information per code. This figure was chosen to minimize the number of contacts in series per code (in the decoding device). In our case, only two contacts in series constitute each code; we think this improves reliability. We use only the first seven channels for coding, keeping the eighth for an error signal. If a hole is punched in channel 8, any code on that digit will be ignored by the equipment.

Apart from the tape punch and reader, all equipment was designed and built by our group, including a punching panel used to control the tape punch machine. The code desired is simply selected with push buttons and a single digit may be punched with that code, or the same code can be punched at a rate of 550 digits per minute.

The reader can read continuously at a speed of 360 digits per minute, or it may be triggered to read a single digit, then wait for another triggering pulse before reading the next digit. There are 8 outputs; one per channel. As each digit is read, any punched channel will result in a 24-volt pulse on its output terminal that lasts for about 70 milliseconds. This pulse duration is independent of the rate at which digits are read. We have modified both punch and reader slightly to serve our purpose, but I'll describe that later.

CFPL control system

In describing the system we use at CFPL I'd like to start with the two ends, then fill in the middle. The paper tape reader has only 8 outputs, but our system has 20 codes available. Conversion is accomplished by a decoder which contains 8 relays. Each relay is energized by a channel on the tape so that when a code (2 bits) is read two relays will close for about 70 milliseconds. With

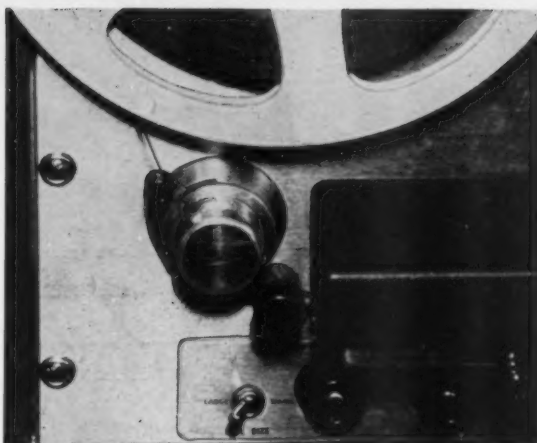


Figure 3.

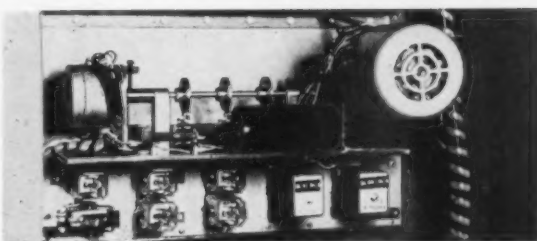


Figure 4.

5 form "A" contacts per relay, combinations of 2 relays produce output pulses on one of 20 circuits.

The end of the system is the bank of magnetic tape machines. In our case, when we started to design this system we were already operating 8 Ampex model 350 tape machines so we decided to adapt them to our system. This meant we had to make them (a) start on receiving a 50-millisecond, 24-volt pulse, (b) stop at the end of the program material and (c) inform the control equipment that they had stopped by sending a 24-volt pulse of about 200 milliseconds duration to the control equipment.

We considered sub-audible tones recorded on the audio tape for cueing the stopping of the audio machines, but eventually ended up with metallic tabs on the audio tape and sensing contacts. Fig. 3 shows the sensing contacts we added to stop the machines. These machines have been doing a good job in automatic programming but we have lost two capstan motor bearings since 24 hour operation of the machines started and we do think that more sophisticated, spring loaded, sensing contacts would be nice to have. We do not, however, think that these machines are ideal for the job and are considering the purchase of more suitable ones.

Because of the continuous music that is a part of the night-time programming we also needed an automatic gain control. We chose to use a reversible motor driving an ordinary 600 ohm attenuator as shown in Fig. 4. The cams on the shaft operate limit switches and the box under the motor at the right is a reducing gear. A permanent magnet clutch reduces stress on all the parts. Beneath the AGC are the relays which provide motor control, pulse extension control and appropriate time delays.

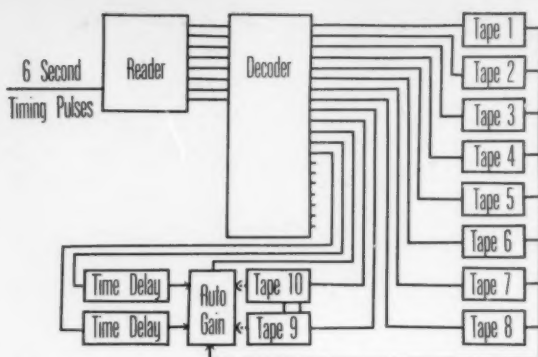


Figure 5.

On time mode of operation

Fig. 5 is a simplified block diagram of the operational mode that we use for most of our current all-night programming. A series of pulses, 6 seconds apart and about 100 milliseconds long, are shown triggering the reader. Each time the reader receives a pulse it reads a digit and advances the tape to the next position. When a code (punched digit) is read, pulses are sent on to close two relays in the decoder (assuming no error code is punched). With the present equipment, a decoder output pulse can do 1 of 13 things: (a) start 1 of 10 tape machines; (b) turn the music up, off, or to intermediate level as background (BG).

To follow the system operation let's assume a status and perform some function. Assume the music is playing at full level and a correct-time announcement is to be inserted over a musical background. First, the reader would have to read a "Music BG" code. When this happens a pulse is sent to this time delay unit. The time delay is required because the reader cannot read another code (the one to start the tape machine with the appropriate announcement on it) for at least six seconds (when the reader is triggered again). A fade taking six seconds is much too long, so thanks to the time delay, the music doesn't start to fade for about 5 seconds.

Six seconds after it reads the Music BG code and one second after the music starts to fade, the reader is triggered by a timing pulse and reads a code to start tape machine number one (the one with the announcement). From now on the reader requires no other code to complete the insert because the time tape will roll and the music stay background until the end of the announcement when the audio tape machine with the time announcements senses the metal tab, stops itself, and sends a pulse back which triggers the auto gain unit. The motor runs the music level back to full up.

All this time the reader is patiently advancing the tape every six seconds. Let's say the next insert is a news broadcast. At the proper time, the first code to be read will be a music off code which will start the other time delay. We use a different delay time for music off because the gain control has further to go so must start earlier. The delay here is about $4\frac{1}{2}$ seconds. Six seconds after it reads the music off pulse and $1\frac{1}{2}$ seconds after the music started to fade, the reader is triggered and reads again. This time the decoder starts tape 2, the one with the news. From here the operation is identical to the previous example.

Triggering the reader accurately every 6 seconds has several advantages. It means that the reader will be triggered 10 times per minute. This, in turn, means that, since the punched tape is transported 1/10 in. per digit,

1 in. of punched tape is scanned each minute, or 5 ft. per hour. Both are convenient figures to work with.

If the timing pulses are accurate the exact time any particular digit will be read can be predicted since the reader can be started on a specific digit at a specific time. Knowing this, we use a numbering stamp along the tape showing the time each digit will be read. It is a simple matter then to punch the tape and know exactly the time each taped insert will be played. For the first time, when the announcer says "12.45," it actually is 12.45!

Fig. 6 shows a section of tape. If we leave 50 digits between the two tape start codes, they will start 5 minutes apart. If we know the time the first tape started we automatically know when the second will start. The mode of operation I have been describing is referred to as the 'on time' mode where things start on time with a minimum of equipment in use. A synchronous motor, of the type used in tape recorders, drives cams to provide the timing pulses.

The 'on time' mode of operation has a serious and obvious drawback; it is the insert using two or more tape machines. The requirement can appear, and did, in the form of a sponsored newscast. It was highly desirable (our sales department had sold it) to add commercials to a few newscasts during the night. Using the 'on time' mode, this presents a real problem. If things are to start only on time pulses, we have to know the exact duration of every insert and they have to be multiples of 6 seconds, or we would have to record all the inserts (news and associated commercials) on one tape. This is difficult since newscasts are recorded at the last possible moment to keep them topical. Anything we do to complicate this recording will be detrimental to our news coverage. Also, if two tapes are included in a single insertion we have to do something about the first one running the music up when it stops.

If an insert uses three machines it opens up a whole new set of problems.

Fortunately, we anticipated all this and our equipment is capable of another mode of operation. This is called a 'feedback' system, but we usually call it the 'off time' mode.

Off time mode of operation

To implement this second mode of operation we use a fourteenth code called the 'off time' code. When this code is punched in the tape and read in the reader, the equipment is rewired in a similar manner to that shown in Fig. 7. In this mode the reader is no longer triggered by timing pulses but by stop pulses from the tape machines. This means that each time a machine stops, the reader is triggered and it will read the next code. This code can start another machine and the sequence of machines can be random and can last until we run out of tapes. The auto-gain control is not affected by the audio tape stop pulses. This mode of operation is common in commercial systems but despite its many attractions, its disregard for time discouraged us for long term usage. However, this mode of operation can be used in our system when required. When it is desired to revert to the 'on time' mode it is necessary to punch and read an 'on time' code on the tape and the equipment will reconnect into the 'on time' mode.

Fig. 8 on its right hand side, shows a sequence of codes we use for some time periods. A series of 8 codes using 8 consecutive digits gets the equipment 'off time,' turns the music off, starts a tape with a time announcement, then a commercial, then news, another commercial, music up full, and back to the 'on time' mode.

During the 'off time' sequence, however, we lose the 'time' sense of the punched tape because the reader is not triggered by timing pulses, and the punched tape is not

transported every six seconds. The digits on the tape are no longer in step with the clock. The 'on time' code, however, triggers a series of events that puts the tape back 'on time,' with the digits back in step with the clock. If, as shown in Fig. 8, 50 digits later a time announcement is to occur, it will happen in 5 minutes from the start of the previous time announcement. (Assuming, of course, that the insert is less than 5 minutes).

Fig. 9 illustrates the system that accomplishes this. The relay on the left represents the transfer relays and is drawn in the 'on-time' mode. Note that the timing pulses are connected to the reader and the audio tape stop pulses are connected to the automatic gain control. This is the on time mode and the equipment will remain wired like this until an insert comes along requiring the use of two or more tape machines. When this happens the 'off time' code energizes the relay and the following happens:

- The reader triggering is transferred from the timing pulses to the audio tape off pulses.
- The audio tape off pulses are removed from the automatic gain control.
- The timing pulses drive a 102 point stepping switch.
- The reader drives a second 102 point stepping switch via a cam that pulses each time the reader reads a digit.

The machine stays in this mode as long as the sequence of tape machines requires (maybe several minutes). All this time the left hand stepping switch is triggered by the timing pulses. Its position counts the number of digits the reader should have advanced if it had been triggered by timing pulses all this time. Each time the reader is triggered, it, in turn, drives the right hand stepping switch. The position of this stepping switch keeps track of the current position of digits on the reader. When the tape insert sequence stops and the music comes up, the 'on time' code is read. All this does is make the reader read at the rate of 360 digits per minute. As it reads it continues driving the right hand stepping switch one step per digit read. When the current position of the digits on the reader, as indicated on the right hand stepping switch, agree with where they should be, as indicated on the left hand stepping switch, a pulse is generated that de-energizes the transfer relays and puts the system back into the on time mode. At this time the digits on the reader are back in step with the clock, the reader is back on timing pulses and the tape-off pulses are back on the automatic gain control. The next insert will occur on time.

This is as far as we have taken the programming facilities of this equipment to date. It works, and works well. It has met our needs, but we have many ideas about refining its capabilities to do more tricks. We think we have only scratched the surface of the potential uses of this equipment, but we know we have the nucleus of a flexible system and all we require for expansion is more imagination.

Department of Transport requirements

As you may have expected, there are certain requirements which must be met to obtain Department of Transport approval for operation of the automatic control equipment. We are currently adding alarm circuits which will provide a warning if any of the following happen:

- any sequence fails to operate as planned
- silence exists for more than 20 seconds
- power fails

In addition to ringing an alarm, this equipment will shut down all audio from itself and start an unrelated tape with an apology for technical troubles and a program of continuous, uninterrupted music. We are planning to have this machine change antenna pattern.

END

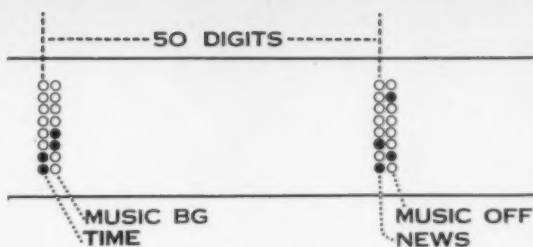


Figure 6.

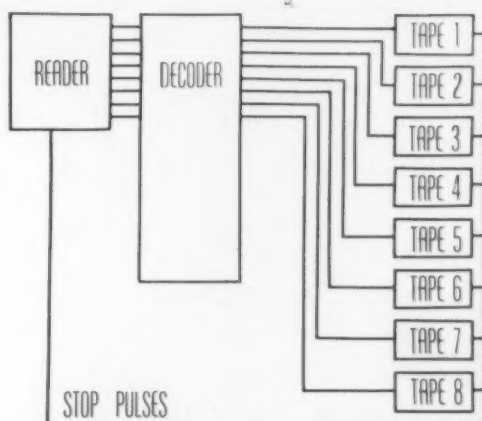


Figure 7.

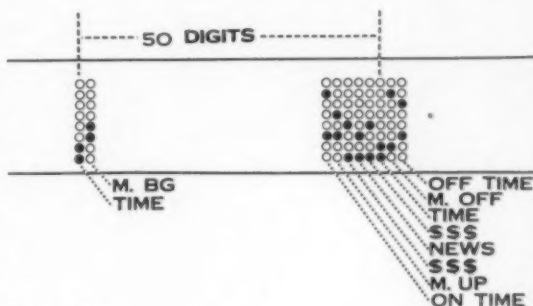


Figure 8.

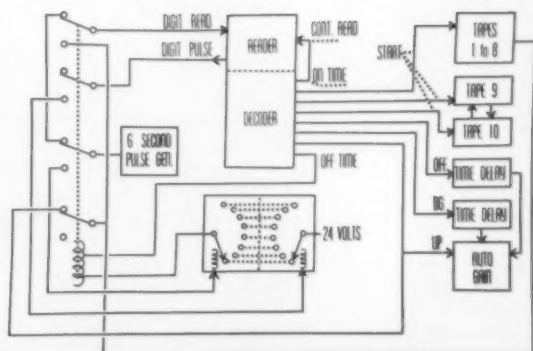


Figure 9.



RCA Victor TK-12 4½-in. 10 camera

Wide range of new equipment is used in Canada's television stations

The recent opening of Canada's new second-channel television stations has focussed attention on the wide variety of new equipment now available, some of it manufactured in Canada. We present here a round-up of the latest in studio equipment, transmitters and antennas, keyed so that you can use our Reader Service cards to get further information.

HAROLD PRICE, EDITOR

Ampex of Canada Limited.

Great flexibility in the production of TV commercials and programs on tape is made possible by the introduction of the Inter-Sync television signal synchronizer (Key No. 150). Now several Videotape recorders may be locked together and synchronized with the output of live cameras, film chains, slide projectors or any other TV signal source. A single VTR may be locked to station sync, thus permitting the station to cut, wipe or lap-dissolve from program to local tape.

The synchronizer accessory, Model 1020, is a rack-mounting chassis that directly replaces the drum servo and capstan signal generator of any Videotape recorder.

The first completely new Ampex audio recorder in five years, the PR-10 is a portable or rack-mounting stereo/monaural instrument for professional use (Key No. 151). The tape transport and electronics are in separate units and occupy a combined rack space of 14 in. Frequency response is within ± 2 db from 30 to 18,000 cps at 15 ips; 40 to 12,000 cps at 7½ ips; 40 to 8,000 cps at

3¾ ips. The use of an eddy-current clutch reduces flutter and wow to 0.15% rms at 15 and 7½ ips, and to 0.25% rms at 3¾ ips.

Benco Television Associates Ltd.

Two additions have been made to Benco's line of satellite transmitters. These are the T-11 and T-12 low-power UHF translators (Key No. 152). Peak video power output on UHF channels 14-84 is 3.5 watts. Model T-11 is designed for inputs on VHF channels 7-13, and T-12 for channels 2-6.

Each translator is contained in a weatherproof housing ready for quick installation and includes remote on and off control facilities.

Canadian General Electric Co. Ltd.

CGE's Series TTC modular television transmitters were designed to meet the need for a complete line of transmitters which can be built up from low to maximum power for both high and low channels, for either main station or satellite station operation (Key No. 153).

The Series TUC demodulated

VHF/VHF translators each consist of two basic units, the translate section and the transmit section (Key No. 154). The translate section is made up of Jerrold and CGE designed equipment which translates the received intelligence into a form that can readily be handled by the transmitter and provide control of the transmit section. The transmit section is a modular transmitter.

First installation in Canada of a new continuous motion film projection system was made recently at CFTM-TV, Montreal (Key No. 155). Incorporating a diffused light system, the new G-E projector practically eliminates the effects of scratches and dirt particles on 16-mm films, and projects a steadier image on the screen.

The improved images are achieved by means of tilting, rotating mirrors that follow the film as it passes over the projection gates. The full capabilities of the Vidicon camera are thus utilized by applying an image to the television system 100% of the time, as compared to the 30 to 50% light application found in conventional intermittent projectors.

CGE have designed and equipped a 50-ft mobile studio for Taylor Video Corp., Toronto (Key No. 156). It permits television programs and commercials to be produced and recorded in virtually any location.

Equipment includes three E.M.I. 4½-in. image orthicon cameras, Ampex Videotape recorder, associated studio gear for the cameras, 16-channel audio system, Telechrome special effects, mobile radio units, and other facilities.

Ultrapower television antennas have been supplied to or are on order for five major stations in Canada (Key No. 157). Typical of these were the 8-slot, 24-gain units made for CFCN-TV, Calgary and CJCH-TV, Halifax, which give a maximum power of 100 kw with a directional pattern.

E.M.I. camera channel Type 203 uses the low-noise 4½-in. image orthicon, 3-in. image orthicon, or the C.P.S. Emitron pick-up tubes, and produces broadcast quality signals on the 405, 525 or 625 line systems (Key No. 158). The five-position turret includes one position for easy withdrawal of the pick-up tube without opening the camera sides, or for mounting a non-standard lens. Other features include facilities for remote control, fitting of any type of zoom lens, and ready adaptability for mobile use.

Central Dynamics Ltd.

Model DIA - 1011 transistorized video distribution amplifier has two types of chassis for 19-in. rack mounting (Key No. 159). Four amplifiers mounted horizontally require a height of 1¼-in. Ten amplifiers mounted vertically require 3½ in.

Specifications include: Input impedance 500 k shunted by 12 pf approx. Gain -3 db to +15.5 db, continuously adjustable. Differential gain less than 0.1 db for 1 v p-p output, less than 0.3 db for 2 v p-p output. Differential phase 0.5 deg. or better for 1 v p-p output. Frequency response ± 0.1 db to 5 Mc, ± 0.25 db from 5 Mc to 8 Mc, less than 2 db down at 10 Mc. Output impedance 75 ohms $\pm 5\%$. Tilt 1% at 60 cps.

Model IMA - 1011 transistorized pre-amplifier and IAA-1011 amplifier have been designed for high quality intercom reproduction (Key No. 160). Solid-state construction offers compact dimensions with long life and no heat dissipation problem. Fifteen pre - amplifiers or eight amplifiers can be mounted in special chassis, each of which occupies 3½ in. of 19-in. rack space.

Type TDC - 2011 audio - video



Ampex Videotape recorder with Inter-Sync television signal synchronizer.



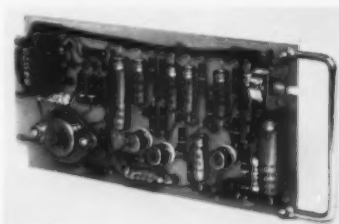
Ampex PR-10 audio tape recorder.



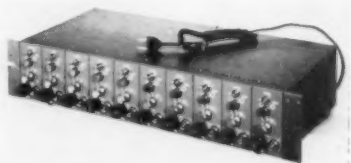
Canadian General Electric Ultrapower high-gain slotted antenna.



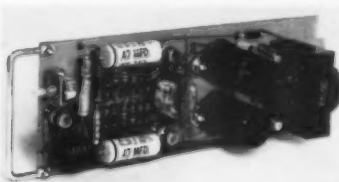
Canadian General Electric modular transmitter with hinged panels.



Central Dynamics IMA-1011 transistorized intercom pre-amplifier (above) and IAA-1011 amplifier (below).

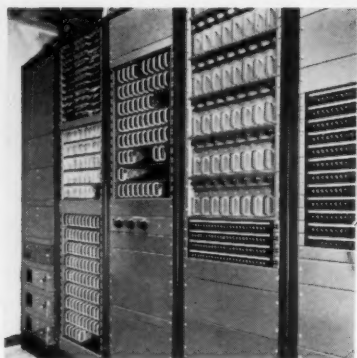


Central Dynamics DIA-1011 transistorized video distribution amplifier.

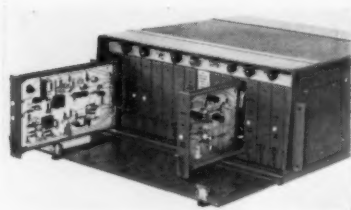


Control room of Canadian General Electric travelling studio.

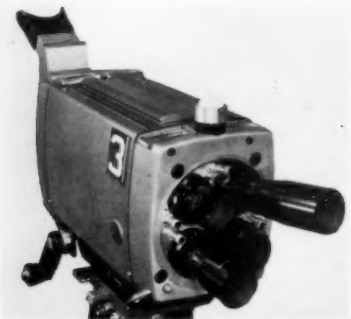
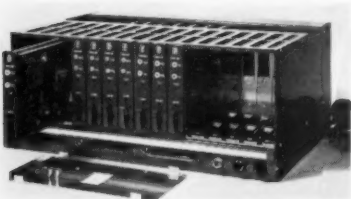
Television equipment



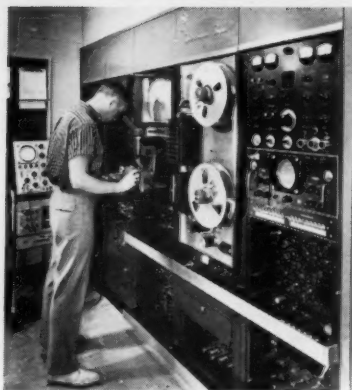
McCurdy SS1026 solid-state intercom system (three racks at left), as installed at CFTO-TV, Toronto.



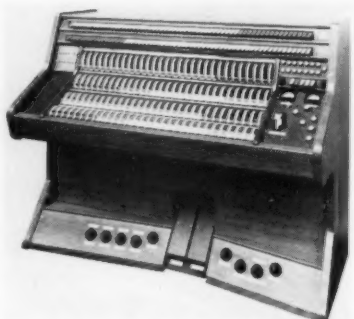
Northern Electric R20861 transistorized sync generator (above), R5900A video distribution amplifier (below).



Pye type 2131 4 1/2-in. IO camera.



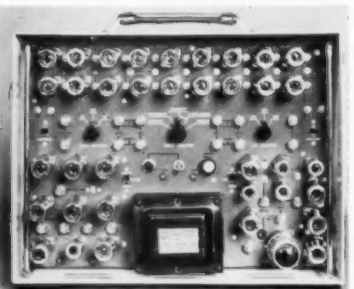
RCA TRT-1A television tape recorder.



Strand Electric lighting control console as supplied to CFTO-TV, Toronto.



Taylor, Taylor & Hobson Varotal III varifocal zoom lens.



Telechrome 1003-D1 portable video transmission test signal generator.

switcher is designed to switch audio and video signals for television tape recording and live programming (Key No. 161). Each video output is provided with an isolation amplifier, while the audio signal is switched directly via a bridging-line transformer. All amplifiers are solid-state with self-contained individual power supplies, and individual crossbar modules permit rapid replacement.

McCurdy Radio Industries Ltd.

The SS1026 television intercom system represents the application of contemporary techniques to the complex problem associated with intercom and audio monitoring (Key No. 162).

The system involves four main functional elements: power supply circuits, power distribution and control circuits, switching circuits, and input/output amplifiers. The heart of the system is a solid-state switching matrix which determines the routing of the path from any message or program source to the desired destination, and performs the required switching functions.

To overcome the attenuation required for isolation in the matrix, both input and output amplifiers are used. Two types of input amplifier are provided: a carbon microphone/line input unit, and a dynamic microphone unit which incorporates compression. Both types of amplifier supply 0 dbm into the 600-ohm input bus. Two types of output amplifier are also available: a full-range unit supplying ± 18 dbm into 600 ohms, and a limited-range unit which provides the same output power but has a tailored frequency response to improve voice intelligibility in noisy locations.

McCurdy also manufacture a range of packaged studio control consoles (Key No. 163). These are described on pages 41-44.

Northern Electric Company Ltd.

The R5900A transistorized video distribution amplifier is a plug-in module with its own regulated power supply (Key No. 164). It has two video outputs, each providing 3 v p-p, and 16 units can be mounted in 7 in. of rack space. This is about half the space required by the same number of vacuum tube amplifiers. Gain can be varied from 0.6 to 2.

Pulse distribution amplifier R-5901A is similar in construction to the R5900A (Key No. 165). Output is a 6-v p-p negative-going pulse across 75 ohms.

Another advance is the R2095A stereo record reproducer (Key No.

166). It has a built-in dual channel equalizer and a combined power supply, control unit and cue amplifier. Other refinements include rumble filters, variable scratch filters and an RIAA flat equalization switch.

R20868 speech input equipment is designed to amplify, control, mix and monitor audio signals in television studios (Key No. 167). It includes facilities for remote control of video tape recorders, turntables, camera control units, etc. Program amplifiers, such as the plug-in R6049A, are included in the speech input equipment (Key No. 168).

N.E.Co. are also making in Canada the R20861 transistorized sync generator (Key No. 169) and the R20500A 8-in. portable video monitor (Key No. 170). Type 724 coaxial cable is colored to match the colors of the video equipment which it connects (Key No. 171).

Pye Canada Ltd., Transmission Div.

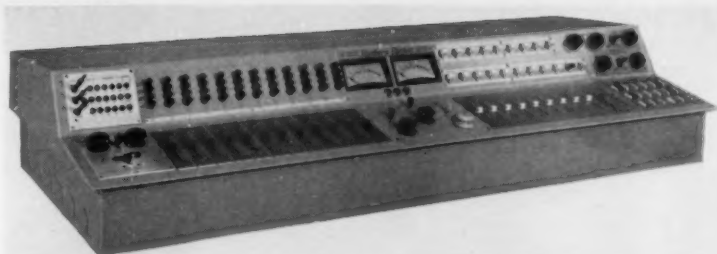
Type 2131 camera will accept 3-in. or 4½-in. image orthicon pick-up tubes and operates on the 405, 525 or 625 line systems (Key No. 172). Special features include an "image orbiting" device which reduces the risk of target "burn-in"; facility for removal of the pick-up tube through the rear of the camera without disturbing the covers or lenses; an automatic registration facility for montage; plug-in chassis to facilitate maintenance or replacement, and a turret design that eliminates the risk of masking by the lens hood of the adjacent long-focus lens when the wide-angle lens is in use.

Other equipment includes the Type 2412 special effects generator (Key No. 173) and the Type 2409 montage unit (Key No. 174).

RCA Victor Company Ltd.

The TK-12 television camera is now being produced in Canada and the first units will be shipped from Montreal in the next few months (Key No. 175). It uses the type 7389A 4½-in. image orthicon pick-up tube and has a built-in 8½-in. viewfinder that can also function as a set-up monitor. Wide use is made of stabilized, transistorized circuitry, which results in a major reduction in the number of operating controls to two: lens focussing and remote iris control.

The TRT-1B television tape recorder consists of an operations centre and a servo unit (Key No. 176). The operations centre includes the tape transport panel and a 17-in. picture monitor and is housed in



Northern Electric R20868C speech input console.

three standard cabinet racks. The servo unit includes the three servo systems which control the headwheel speed during record and playback, tape speed and guide position during playback. The equipment and its related power supplies is mounted in a two-rack assembly which may be placed with the operations centre or at a remote location.

The TS-40 video switching equipment provides reliable, all-electronic switching (Key No. 177). The plug-in units are completely interchangeable and the modular design provides for system flexibility up to 24 inputs and 10 outputs. Picture transition is complete within 2 usec, switching taking place during the vertical blanking interval. Interchannel cross-talk isolation is at least 55 db.

Other relatively new items include the VHF traveling wave antenna (Key No. 178) and the special effects system (Key No. 179).

Strand Electric Limited.

The electro-mechanical servo type of studio lighting control system offers the most economical way of controlling large number of dimmers, which can be either of the transformer or the variable load resistance type (Key No. 180). Each dimmer remains at the position to which it was last called and the control positions are not concerned with sustaining circuits. In fact, once a dimmer is moved to a specific position, the control can be virtually disconnected.

This simplifies design of the control console since there is no need to repeat control potentiometers to the extent necessary with all - electric dimmers. In addition to the dimming potentiometer, each circuit has an organ console type stop key. These can be arranged into any desired combination of groups and recalled or dismissed instantly by a set of 14 or more "memory" push-buttons. Action results whenever the master controls are used: to switch on lights, to raise or lower the dimmers, or to

switch in the individual dimmer levers for intermediate levels. The operator only has to think in terms of circuits which must be changed.

Taylor, Taylor & Hobson Ltd.

One highly specialized component of the television equipment field which receives relatively little publicity, but is extremely important, is the television camera lens. The Varotal III, a new varifocal zoom lens, is the latest in the series of TTH lenses which are in use in most television stations across Canada (Key No. 181).

The application of several new optical design concepts, plus the development and manufacture of precision aspherical glass components, has resulted in a lens that maintains absolute focus over a zoom range from 4 in. to 40 in., and provides definition equal to the best produced by any fixed lens. The Varotal III is fully color-corrected, and is equally effective on both color and monochrome cameras. It is available with either manual or servo controls.

Telechrome Manufacturing Corp.

Model 491A special effects positioner considerably extends the capabilities of the Model S490A special effects generator (Key No. 182). Selective positioning—controlled by a "joy-stick" type lever—and variable modulation provide new and dramatic effects. The equipment further enables the positioning of complex wipes generated by a camera or flying spot scanner. Lighting effects may also be electronically produced.

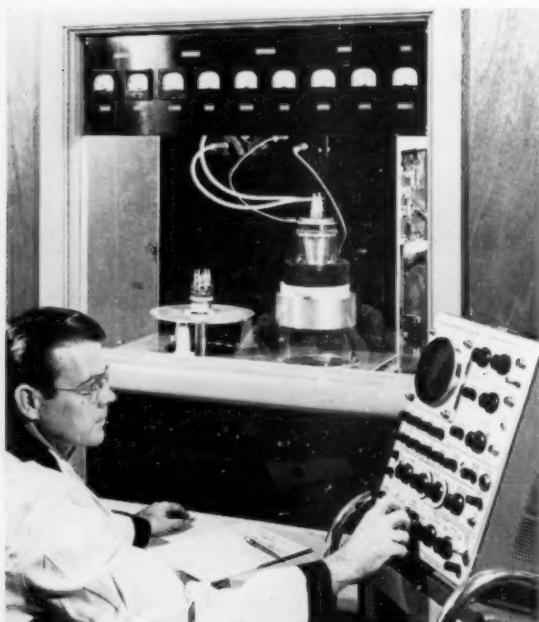
Model 1003-D1 test signal generator now incorporates all video transmission test standards in one 12¼-in. portable or rack-mounting package (Key No. 183). It produces composite waveforms for checking amplitude vs frequency, differential gain, differential phase, dynamic linearity, high frequency transient response, low frequency phase shift or streaking, smears, mismatches, etc.

END



Supervisor George Morton makes adjustments on camera used to test image orthicons in Canadian Marconi laboratory.

New facility tests special purpose tubes



Technician checks pulse performance of type BR1102 tube.

HAROLD PRICE, EDITOR

A testing laboratory for camera tubes has been in operation at Canadian Marconi's Electronic Tube and Components Division in Toronto for the past two years. Its facilities have now been extended to provide for pre-testing special purpose broadcast and industrial tubes. Customers receive only tested tubes and warranty actions are speeded up.

A new laboratory for testing special purpose broadcast and industrial tubes has been established by the Electronic Tube and Components Division of Canadian Marconi Company in Toronto. It is believed to be the first time such facilities have been available in Canada. A similar testing laboratory for television camera tubes has been in operation at Marconi for over two years and the value of this facility prompted extension of the testing operations to include special purpose tubes.

Most special purpose tubes used in Canada are imported. When the tubes are just re-shipped to the customer, shortcomings in them may not be discovered until they are in service. Delays incurred while the defective or

(Continued on page 58)

Symposium will feature standards for machine tool control

Leading authorities on production engineering will take part in a symposium in Toronto May 10, to discuss "Machine tool programming data preparation." The following afternoon another panel will discuss "Unification of instruction media for machines."

This two-part symposium will be part of the technical program arranged for the annual conference of the Production Engineering Division of American Society of Mechanical Engineers. The conference will be held concurrent with the National Industrial Production Show in Toronto, May 8-12.

Delegates are expected to tackle the problem of developing a common standard for use in punch-card and tape-control programming of machine tools. At present, there are as many different systems in operation as there are makers. All use tapes of different widths and materials and employ various methods of recording information to be fed to the machines.

Morning session and luncheons will be held at the Royal York Hotel; afternoon sessions at the Production Show, Exhibition Park. A program of 22 technical papers has been arranged.

Industrial electronics course

Electro Sonic Supply Co., with cooperation from Canadian General Electric Co. Ltd., is presenting another course in industrial electronics. In previous courses they have had over 600 registrants.

The course is intended to provide technicians with a better understanding of how electronic equipment works and is utilized in industry. Graduates will be qualified to take an active part in the use, application and maintenance of this type of equipment.

Persons interested in news about future courses should write to Mr. C. D. MacKenzie, Electro Sonic Supply Co. Ltd., 543 Yonge St., Toronto.

Management day at ISA Toronto conference

A one-day Management Symposium on Monday, June 5, will be the initial highlight of the ISA International Instrument-Automation Conference and Exhibit, Toronto, June 5-8, 1961. The morning session will be introductory and will orient management at-

tendees to the available data processing and computation tools and current concepts. Featured speaker at the morning session is Mr. Tivey, The Foxboro Co., Foxboro, Mass.

The afternoon session will be devoted to application experiences in several industries which will reflect how computers have influenced company organization and the resultant economic impact.

Due to increasing interest in strain gauge techniques, expressed by several members of ISA, two of the technical sessions have been allocated to this subject. A number of papers have been received from widely scattered points in Canada and the United States.

All sessions will be held in the Royal York Hotel; exhibits will be in the Queen Elizabeth Building, Exhibition Park, Toronto.

Symposium on titrimetric methods

The Analytical Chemistry Division of The Chemical Institute of Canada is sponsoring a symposium on titrimetric methods at Cornwall, Ontario, May 8, 9, 1961.

Sessions will be held May 8, and the morning of May 9. Tours have been arranged for the afternoon of May 9. Chairman of the symposium is D. S. Jackson, Courtaulds (Canada) Ltd., Cornwall, Ont.

Further information may be obtained from The Chemical Institute of Canada, 48 Rideau St., Ottawa 2.

A "small" error

The October issue of CEE carried a report on the opening of the Canadian Division of Weltronic Company, and named the general manager as Mr. Eugene Smith. Readers trying to find Mr. Smith would have had difficulty; his real name is Eugene Small.

Standards set on control elements

With the increasing development and application of systems engineering throughout industry today, dynamic response test data are becoming an important part of over-all performance. These data provide significant and valuable information for the selection of proper components for control systems used in industry. To obtain this information, a number of uniform and comparable tests and laboratory practices must be devised. To this end, the Instrument Society of America, through the program of its Standards & Practices Department, has developed a series of Recommended Practices dealing with Dynamic Response Testing of Process Control Instrumentation.

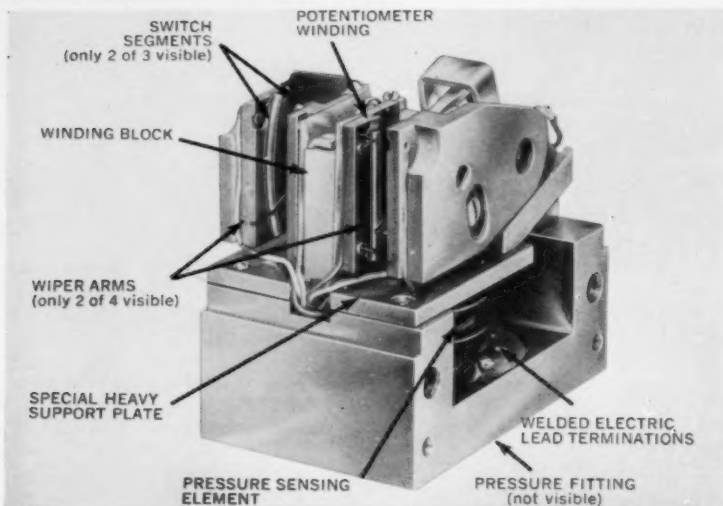
The most recent intended addition to this series is a draft of practice for the testing of final control elements and actuators. This draft, ISA-RP26.4, prepared by the Standards & Practices Department's 8D-RP26 Committee, covers "Dynamic Response Testing of Final Control Elements and Actuators." Throughout

(Continued on page 64)



These are some of the members of the Toronto Host Committee, ISA Instrument Summer Conference and Exhibit. Standing left to right are R. G. Clarke, Orenda Engines Ltd., information chairman; R. J. Reeves, F. W. Chambers Co., exhibit space chairman; R. Ellis, Taylor Instrument Co. of Canada, conference rooms chairman; W. Pass, Martin Engineering Inc., membership chairman; L. Jankouski; G. F. Crossman, Fischer & Porter Canada Ltd., publicity chairman. Seated left to right are K. Vriesen, DeVry Technical Institute, district 10 vice-president; J. Pefhany, Orenda Engines Ltd., executive chairman; J. R. Rogers, The Bristol Co. of Canada Ltd., general chairman; H. Dunsmore, Moore Instrument Co. Ltd., secretary-treasurer. Conference dates: June 6-8.

New components



Pressure transducer 113

Fairchild Controls Corp. pressure transducer type TP-200 is designed to measure absolute, gauge or differential pressures of corrosive or non-corrosive gases or liquids in the 0-5 and 0-500 psi full-scale range. It is a potentiometer type transducer that uses a versatile, temperature - compensated mechanical amplification system to combine the high output signal and accuracy characteristics of potentiometer output elements with the reliability, ruggedness and responsiveness of a capsular Ni-Span-C diaphragm. Linear or non-linear potentiometer outputs are available as standard, but switch and rheostat outputs and other types of pickoffs can be supplied.

R. D. B. Sheppard, Ottawa.

Metox insulated power resistors 114

Series F power resistors are composed of a metal oxide element bonded to a porcelain rod at red heat. This process results in a resistor which is rugged, both electrically and mechanically. The durable coating is intended to provide an insulating cover rather than to protect the element which in itself is highly resistant to mechanical damage and effects of moisture.

Welwyn Canada Ltd., London, Ont.

Small 4pdt relay 115

Series KHP, 4pdt relay has been designed for long life. Only slightly larger than one cubic inch, the relay has been operated under light load for more than 100 million cycles with less than 5% variation in electrical characteristics. Relays are rated for loads ranging from dry circuit up to 3 amps at 30 vdc or 115 vac resistive. Contact arrangements of 4 Form C and 2 Form Z are available.

Coil operating voltages range from 6 to 110 vdc.

Potter & Brumfield Canada Ltd., Guelph, Ont.

Solid state white noise generator 116

Sounvistor is capable of producing random noise across a white noise spectrum. The solid state device can also be used in selected frequency ranges known as yellow and pink noise bands. The 3/8-in. Sounvistor will have application in the medical field of audio analgesia.

E. S. Gould Sales Co., Montreal.

Flexible printed circuitry 117

Garlock Electronic Products has incorporated Teflon FEP into flexible printed circuitry which can be bent or twisted into any desired shape to allow maximum design freedom without compromising over-all reliability. It can be designed to conform exactly to package contours and component parts. Terminations which are adaptable to common industry standards are offered. The etched copper circuit is completely encapsulated between two layers of Teflon FEP.

Lake Engineering Co. Ltd., Scarborough, Ont.

Flux aids soldering of magnets 118

With the use of Lonco Organo-Flux No. T-64-C, it is now possible to solder plain Alnico magnets to bare steel pole pieces. This water-based flux has good soldering "take" and holding power under prolonged heat, and the residue may be rinsed away with water.

Paisley Products of Canada Ltd., Scarborough, Ont.

(Continued on page 67)

New equipment

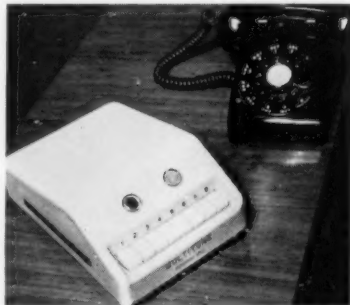
Automated announcer 119

Designed for use in airports, bus and railway terminals, Westrex automated announcer permits segments of pre-recorded magnetic tape loops to be selected and played sequentially. Two hundred and seventy combinations are possible from the basic system. The system utilizes up to 50 magazines and will synthesize up to 3 segments into one free-flowing continuous announcement. Automatic re-cueing of each segment back to its beginning and the stepping from one segment to the next is accomplished with a sub-sonic control tone recorded on the tape at the same time as the announcement.

Tele-Radio Systems Ltd., Toronto.

Transmitter for personal call system 120

A new battery-operated transmitter has been introduced for use in a personal call system. It provides either speech or private signal for a total of 15 personnel carrying pocket receivers. Fully transistorized and battery operated, the transmitter has been designed for medium sized installations. Radiation of the signal is achieved by means of an induction loop surrounding the area to be covered.



Multitone of Canada Ltd., Toronto.

Power screwdriver 143

Foredom Electric's miniature power screwdriver doubles as a nut-runner and has been designed for assembly work on small parts. The driver operates off a flexible shaft and is powered by a 1/10 hp, 110 v, universal motor with adequate torque for screws and nuts up to size No. 4. The slim handle weighs only 5 1/2 oz.

Empire Engineering Co., Toronto.

Regulated power supplies 121

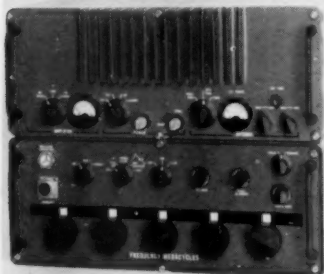
Kepeco series SM power supplies offer outputs of 0-160 vdc at 4 amps (model 160-4M), 2 amps (model 160-2M) or 1 amp (model 160-1M). Load regulation is 0.1% or 3 millivolts, whichever is greater, for no-load to full-load change.

Line regulation is 0.1% for 105-125 vac line change. Stability is 0.1% or 6 millivolts, whichever is greater, over 8-hour period after 1 hour warm-up. Ripple is less than 1 millivolt rms. Regulation of 0.01% is available as an optional feature.

Ward Leonard of Canada Ltd., Toronto.

SSB communications equipment 122

SSB communications equipment featuring digital tuning, which locks on any one of 28,000 frequencies from 2.0 to 30.0 Mc, has been developed by Stromberg - Carlson Div. The new



transceiver, designated SC-901, is the first item in a line of SSB equipment to be introduced with power output levels ranging from 100 watts to 1 kw (peak envelope power).

Hackbusch Electronics Ltd., Toronto.

Light-sensitive time control 123

A light-sensitive time switch, introduced by Tork Time Controls, Inc., combines mechanical switching with a photoelectric control. The unit is for automatic on/off control of building and heavy lighting loads. A light-sensitive cell mounted outside the building turns lights on automatically when needed, regardless of the time. It acts when light drops and remains at 2 to 4 foot candles for more than 30 seconds. A time switch mounted inside the building and wired to the cell, turns lights off at any pre-set hour so that lighting need not be kept on until dawn. One model will permit omission of operation on Sundays or other pre-selected days.

Dominion Electric Mfg. Co. Ltd., Toronto.

Pipeline viewing camera 124

This closed-circuit television camera, developed by GPL Div., can be used to explore inside pipes as small as 4 inches in diameter. The camera is watertight to a depth of 10 ft. and 5 psi pressure. It has a built-in light source of 30 ft. candles at 1 ft., and a removable rotating mirror for axial or radial viewing. The camera has been designed for use with type GPL 151 camera control unit which provides remote operation of focus and mirror rotation.

Northern Electric Co. Ltd., Montreal.

(Continued on page 72)

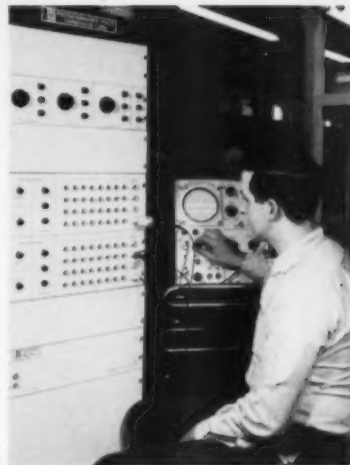
New instruments

Programmable pulse generator

125

Type 2104 programmable pulse generator is capable of rapid analysis, testing and programming of thin film and cryogenic devices. It also finds application in the testing of magnetic toroid and transfluxor memories, as well as in the testing and evaluation of digital and analog circuitry. The 2104 is capable of running at a clock frequency higher than 4 Mc, at levels having 25 nanosec rise times and 50 nanosec widths. It will deliver four separate trains of both logical levels and pulses. Each of the eight output trains is separately programmable into eight time zones. Utilizing step repeaters to give time zone lengthening capability, the 2104 can be programmed to generate bursts of levels or pulses from 5 to 1,000 usec in full synchronization with the 2½ volt negative going pulses.

Digital Equipment Corp., Maynard, Mass.



High megohm bridges 126

Mid-Eastern Electronics has designed two bridges for measurement in the ultra high resistance ranges. Model 801 bridge is a self-contained unit complete with built-in battery, electrometer amplifier galvanometer and nine plug-in ratio arms. Its working range covers 1,000 ohms to 1.1×10^{14} ohms. Accuracy in the measurement of resistance is guaranteed from 0.08% in the 1,000-ohm to 1,100-megohm range, to 0.80% in the higher ranges.

Model 802 bridge is identical to the model 801 except that a 100 meg decade (ten steps of 10 megohms per step) is included, and the 100 ohm decade of the model 801 is omitted.

Willer Engineering & Sales Co., Toronto.

Transistor counters 127



Models 5212A/5512A/5232A/5532A instruments comprise a new family of Hewlett-Packard transistor counters. Two basic counters provide maximum counting rates of 300 kc and 1.2 Mc, with a choice of column or in-line readout. Dual use of decade dividers in the instruments permits multiple period average measurements, with a resultant increase in accuracy. A display storage feature provides continuous visual readout of the most recent measurement,

even while the counter is gated for a new count. If the new count differs from the stored count, the display will shift to the new reading directly. The display storage reduces operating errors and increases the counter's flexibility.

Atlas Instrument Corp. Ltd., Toronto.

Strain gauge equipment 128

A recent introduction by Bruel & Kjaer has been an automatic selector type 1542 and a twenty-point panel type 1543 which are for use in conjunction with their strain gauge apparatus type 1516. Basically, the selector consists of a fifty-position switch, terminals, and R and C balancing components for the connection of 10 full or half strain gauge bridges. Where numbers to be measured are in excess of ten, this has been catered for by the type 1543 panel. To obtain 50 measuring points, one type 1542 and two type 1543 panels may be used together. The selector switch can be operated manually or automatically at measuring intervals of 0.5, 1, 2 or 4 seconds.

R-O-R Associates Ltd., Don Mills, Ont.

Precision Kelvin bridge 129

Model LB-14 portable Kelvin bridge is a self-contained bridge for measurement of resistors from one ten millionth of an ohm to 10.1 ohms, with an accuracy from 0.1 to 0.3% for all values above 0.0001 ohms. A built-in battery and galvanometer give true portability; provision is made for using the bridge with an external battery and galvanometer.

Canadian Research Institute, Toronto.

(Continued on page 71)




AMPEX Instrumentation Tapes

are premium quality magnetic tapes designed for analog recording by any of the basic techniques.

Magnetic properties include high sensitivity, and a wide dynamic range with a stable output throughout the life of the tapes. Exceptionally smooth, hard surfaces provide cleaner operation with less oxide shed, offering greater reliability and reduced maintenance. These tapes are available in configurations for a wide variety of applications.

They are offered on acetate or Mylar® backing films, in thicknesses of 0.6, 1.0 and 1.5 mils, and in various widths and lengths. All are supplied

on high-performance Ampex Precision Reels or on NAB-type reels. For application information write to Ampex of Canada Ltd., 607 Commonwealth Bldg., Ottawa, Ontario 

• DUPOIN TM

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Special purpose — continued

damaged tube is returned to the European or U.S. manufacturer are a serious inconvenience to the Canadian customer. By pre-testing the tubes before they are shipped, delays and inconvenience are eliminated.

Action on warranties is also speeded up in those cases where a customer wishes to make a claim under the warranty after a tube has been put into service. The necessary tests can be made in the Toronto laboratory and the warranty honored without shipping the tube to the manufacturer in Europe or the United States.

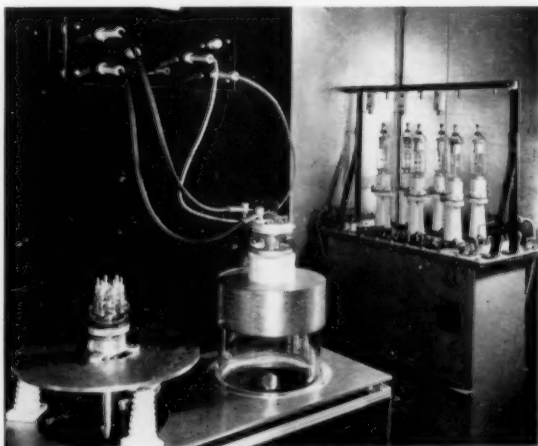
The laboratories for testing both camera and special purpose tubes are run by George A. Morton, supervisor of technical services. He is assisted by Alex Smart, electronics technician, and Art Ferry, technical sales representative. Mr. Morton demonstrated the new facility during a recent visit by the writer.

The new equipment is housed in a pressure-controlled room located next to the camera tube laboratory. Tubes under test are mounted on a fixture which includes a blower to provide the proper flow for air-cooled units. Facilities are also available for testing water or vapor-cooled tubes. A variable filament supply capable of providing up to 350 amps at 12.5 volts, a 10-kilovolt direct current power supply, a capacitor-discharge pulse testing supply, and associated equipment and connections are also in the sealed room.

First test on all tubes on arrival is a milliohm-meter check of filament resistance. The tube is then mounted on the test fixture, filament and electrode connections are made, and the appropriate cooling is applied. The filament voltage is then brought slowly up to the rated value by means of the servo-controlled supply. After a five-minute wait to ensure that proper filament temperature has been reached, the bias and other supplies are brought up to the test voltages. All controls for these supplies are located on the outside wall of the test room below an observation window, with the corresponding meters mounted above the window.

All but the filament supply circuits are interlocked with the door of the test room as a safety precaution. The high-voltage circuits are also interlocked with the bias supply so that they will be opened in the event of bias failure. In addition, a "rip-cord" is provided convenient to the operator's hand, by means of which the supplies can be disconnected if he observes anything unusual while a test is in progress.

END



Work-horse of new laboratory is this 10-kv power supply.



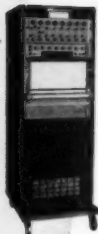
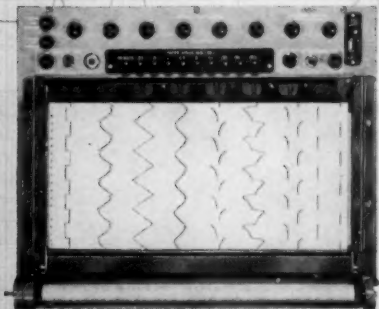
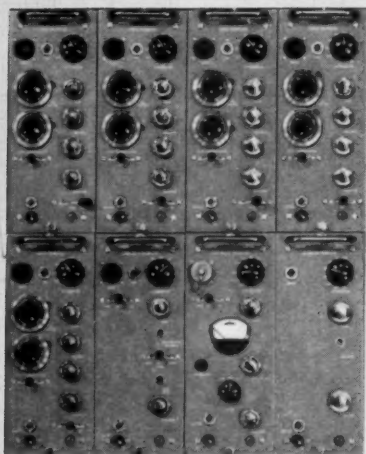
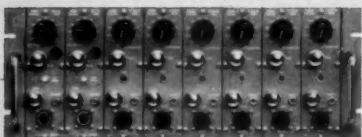
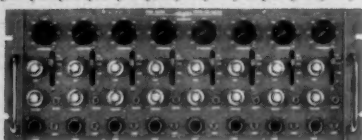
The AMPEX CP-100 is a compact, extended-frequency instrumentation tape recorder/reproducer. Tape transport, motor drive amplifier, heads, power converter, controls and all-transistorized plug-in record/reproduce electronics are contained in a single 13¼" x 19" x 33¼" mobile case. The CP-100 operates on 28-volt DC, with 48 to 400 cycle converters available for other power sources. Data is recorded by direct or FM carrier techniques on up to 14 analog tracks. The CP-100 offers frequency response to 200 Kc at 60 ips or expanded recording time of 24 minutes for 100 Kc data at 30 ips on a standard 10½" reel. Transport tape speeds — 1⅞, 3¾, 7½, 15, 30 and 60 ips — and plug in frequency determining units and equalizers associated with tape speeds, may be quickly changed. The versatile and mobile CP-100 performs reliably over a temperature range of from -50° F to +160° F, up to an altitude of 10,000 feet, in relative humidities to 95%... and is designed to withstand shocks and vibrations encountered in rugged mobile testing applications. This recorder may also be rack mounted if desired. For complete details write Ampex of Canada Ltd., 607 Commonwealth Bldg., Ottawa, Ontario. **AMPEX**

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Sanborn

has probably already designed
your "custom"
oscillographic
recording system

"Building block" recorder and amplifier design permits maximum flexibility to meet specific application needs



950 Series — truly low cost — identical channels

6 or 8 identical DC recording channels — either high gain, 10 uv/div; medium gain, 0.5 mv/div; or low gain, 10 mv/div. Medium and high gain types are completely transistorized, have floating and guarded input circuits. Frequency response DC to 150 cps within 3 db, 10 div peak-to-peak with low and medium gain systems, to 100 cps with high gain system. Amplifier panel space only 7" x 19", recorder 17½" x 19".

850 Series — economical, flexible — miniature plug-in preamps

Interchangeable plug-in preamps, eight to a 7" high module, available in Phase Sensitive Demodulator, DC Coupling, Carrier and Low Level types. System response to 150 cps within 3 db, 10 div peak-to-peak, depending on preamps used. Input circuits single-ended, push-pull, or floating and guarded, depending on choice of preamp.

350 Series — versatile, high performance — interchangeable preamps

Provides greatest possible application flexibility, with interchangeable preamps in Carrier, DC Coupling, Phase Sensitive Demodulator, Differential DC, Low Level, Logarithmic and Frequency Deviation types. System response DC to 150 cps within 3 db at 10 div peak-to-peak — input single-ended, floating and guarded, or push-pull — depending on preamplifier used. Eight preamps in two 4-unit modules occupy 21" x 19" of panel space; usable separately with individual power supplies to drive meters, 'scopes, etc.

"350" style Recorder Assembly — used in all the above systems. Provides transistorized, plug-in, current-feedback power amplifiers . . . low impedance, velocity feedback damped galvanometers . . . 8" of visible record . . . 9 electrically controlled chart speeds . . . inkless traces on rectangular coordinate charts . . . flush front recorder, vertical chart plane. Recorders with horizontal chart plane also available for 350, 850 and 950 systems.

Sanborn oscillographic recording systems also include the tube-type 1- to 8-channel "150" Series with 12 plug-in preamplifiers; and the "650" 1- to 24-channel optical oscillograph with response to 5 KC and 8-channel amplifier available separately for driving any galvanometer. For complete data contact one of the Sanborn Sales-Engineering representatives located in principal cities throughout the United States, Canada and foreign countries.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

IRE News

Conference advisory committee



Ballard



Barclay

An advisory committee of leading business and scientific men has been appointed to assist the IRE Canadian Electronics Conference executive.

Two members are introduced in this issue: others will be presented in future issues.

Dr. B. G. Ballard is Vice-President Scientific, National Research Council.

A. P. H. Barclay is the immediate Past Canadian Region Director, Institute of Radio Engineers.

The IRE Canadian Electronics Conference will be held at Exhibition Park, Toronto, October 2-4, 1961.

Technical papers

Prospective authors should remember that May 15, 1961 is the deadline for submitting summaries of papers for the IRE Canadian Electronics Conference. Papers may be on any topic of general interest to engineering, management, government or college members of the Institute of Radio Engineers.

Send 500-1,000 word summaries to A. R. Low, Chairman, Technical Program Committee, IRE Canadian Electronics Conference, 1819 Yonge St., Toronto 7.



Despite the worst efforts of the weatherman with a snow storm, the Toronto Section IRE held a successful stag March 13. Highlight of the evening, besides the buffet, was a talk "A civilian's life in Thule, Greenland," by B. E. Davies.

Section meetings

Ottawa: May 19; this will be a field trip with a visit from members of the IRE Syracuse Section.

Toronto: April 24; "Controlling traffic in Metropolitan Toronto with an electronic computer" by L. Casciato, Traffic Research Corp. Ltd.; Hart House, 7 p.m.; dinner in the Great Hall at 6 p.m. Toronto Section elections will be held the same evening.

Winnipeg: April 14; Annual Meeting and dinner dance, Rossmore Golf and Country Club. Election of Officers will be held.

Studying at the source

The Bay of Quinte Section of IRE held its regular February meeting in the Junior School Auditorium at the Ontario School for the Deaf in Belle-

ville. The address was "Binaural systems as an aid to teaching the deaf." It was given jointly by J. Boyd, Audiological Services Advisor at the Ontario School for the Deaf, and A. Jamroz, Supervisor of Audio and Video Development of the Research and Development Div., Northern Electric Co. Ltd.

The speakers gave a report on the methods used in evaluating hearing ability, and the results of tests using monaural and binaural systems. A tour was provided of a typical classroom equipped with hearing aids, and the Audological Clinic where hearing ability is evaluated with an audiometer and other electronic equipment.

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CANADIAN ELECTRONICS CONFERENCE

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THE TIME

OCTOBER 2, 3 & 4, 1961

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Automotive Building,
Exhibition Park, Toronto

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Canada's largest scientific event—drawing over 9,000 scientists, engineers and business men from industry and the armed services. They'll be there to study the Industry's latest products and techniques.

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SPONSORED BY THE CANADIAN SECTIONS OF THE INSTITUTE OF RADIO ENGINEERS

6101

Reports—continued

Associated Electronic Components Ltd., Toronto, are now the Canadian agent for **Alma Components Ltd.**, London, England (precision wirewound resistors).

North Hills Electronics, Inc., Glen Cove, L.I., N.Y., has appointed Terminal Radio Int'l. Ltd., New York, N.Y. as their foreign rep. (communications components, precision constant-current and constant-voltage ac-dc sources).

Radionics Ltd., Montreal are the new Canadian sales reps. for **Servo Corp. of America**, Hicksville, N.Y. (military infrared systems and components, air navigation and traffic control systems, railroad electronic equipment, test instruments, industrial control systems).

Marsland Engrg. Ltd., Kitchener, Ont. have acquired the Canadian sales and manufacturing licenses for the military electronic products of **John Oster Mfg. Co., Avionic Div.**, Racine, Wis. (servos, synchros, motor-tachs, resolvers, computers, indicators, dc motors, servomechanisms

and servo torque units). Marsland will first produce servo packages to Oster designs.

Rogers Electronic Corp., New York, N.Y. are now represented by Canadian Marconi Co., Electronic Tube and Components Div., Toronto (transformers, yokes and coils).

PARL fire damage estimated at \$1,400,000

A Board of Enquiry, convened to investigate the fire that damaged the Defence Research Board's Prince Albert Radar Laboratory on January 31, has reported that the fire apparently was caused by an oxyacetylene torch during the construction of a wing connected to the main laboratory structure.

Flames which developed between the inner and outer walls of the main building proved difficult to control despite efforts of the laboratory staff and of the Prince Albert Fire Department.

Replacement cost of the building and the equipment destroyed or severely damaged is estimated at \$1,400,000. The 90-ft steel and concrete tower, the 84-ft diameter dish, receiving and test equipment and other facilities all valued at \$2 million were saved. Antenna control equipment and the transmitting, receiving and data processing systems (see CEE, August 1960) suffered severe damage.

Scientific operations on a limited scale will be resumed almost immediately. The Board plans to construct a new laboratory building this year and the long-term research program will be phased-in as damaged equipment is replaced.



NEW VHF-POWER SIGNAL GENERATOR*

- Frequency scale over 20 inches long
- Regulated output voltage within 5% independent of frequency and load variations
- Oscillator coarse and fine tuning
- Frequency range 4 Mc/s to 960 Mc/s with 7 plug-in units
- Output power 1 watt max.
- Frequency accuracy better than 1%
- Amplitude modulation 100%
- Output voltmeter 0.5 to 10 volts



The output level of this new VHF-Power Signal Generator Model LMS-68 is kept automatically constant by electronic stabilization, ensuring fast convenient measuring.

Individual oscillator plug-in units may be used separately in one or more of the other Wandel & Goltermann measuring sets.

Each plug-in unit is shielded and can be operated as a separate generator.

For complete information write or call R-O-R

*Manufactured
by
**WANDEL &
GOLTERMANN**

R-O-R ASSOCIATES LIMITED
1470 DON MILLS RD., DON MILLS, ONT.

For further information mark No. 51 on Readers' Service Card



Commodore A. G. Boulton, right, and Commander F. C. Palmer, left, both of the Canadian Joint Staff, are shown the first of the RA.17C-12 communications receivers to be delivered to the RCN against a \$500,000 contract obtained by Racal Engineering Ltd. Centre is R. F. Brown, Racal chairman and managing director. The U.K. firm is represented in Canada by Instronics Ltd., Stittsville, Ont.

Ottawa report—con't.

evidence from the universities, provincial research institutions and private industry.

Among industries scheduled to be invited to appear are the chemical, pulp and paper, electrical and perhaps electronic industries. In addition the Canadian Manufacturers Association will be asked to submit a brief.

Purpose will be to throw light upon the relationship between government and industrial research and to determine the effectiveness of NRC's present system of helping industry.

Later this session the committee will turn to Atomic Energy of Canada Limited and plans to hear all views, favorable and unfavorable, upon the policies of AECL. Two committee members who have made a special study of Canada's atomic energy program are Alexander Best (PC — Halton) and Gordon Aitken (PC — Parry Sound-Muskoka.)

Mr. Best said in an interview the committee hopes to get away from the kind of generalization "research is a good thing, we should have more of it in Canada" to some specific and positive recommendations.

Electrical manufacturers will buck the general trend of manufacturing industries in 1961 and invest more in new plant and machinery than in 1960. Plans call for an outlay of \$33.4 million, up from \$32.3 million in 1960.

Though the increase is small it is in contrast to the smaller investment programs of almost every other type of industry except chemicals and oil and gas.

This estimate comes from the report of the Trade and Commerce Department on public and private capital spending programs for 1961.

Manufacturers of electrical apparatus and supplies will spend \$7.9 million on new construction in 1961, up from \$6.9 million last year. Another \$25.4 million will be spent on new equipment and machinery, the same as the year before. In addition repairs to plant and equipment will take up \$18.7 million.

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7" high, 16 gauge steel center strut for ease of equipment mounting and greater over-all structural strength.



14 gauge steel frame construction assures greater ruggedness and rigidity.



Electronically controlled spot welds assure superior strength.



Jig assembly line fabrication provides rigid quality control and assures compatibility of frames.

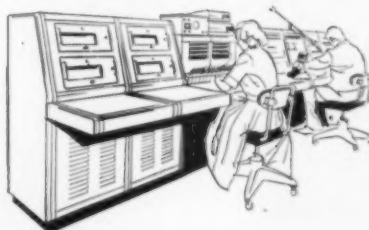


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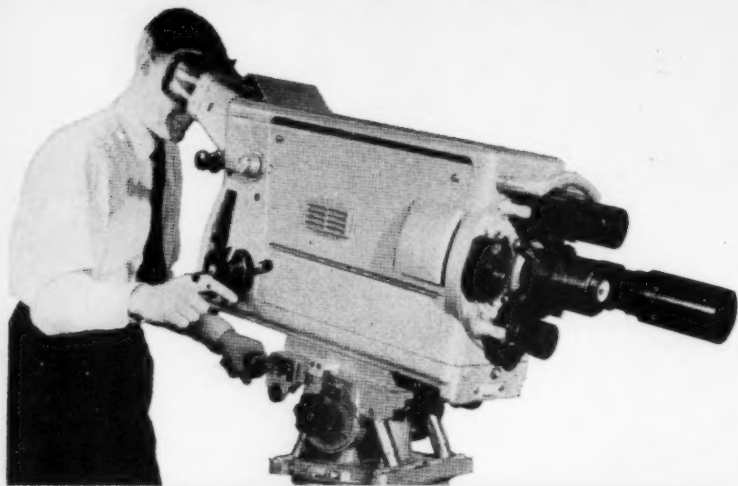
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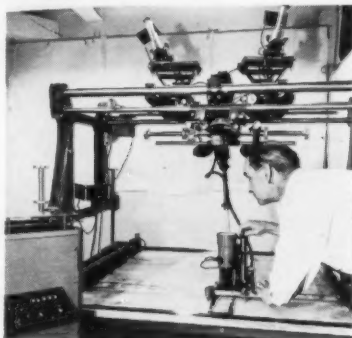
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Control—continued

its preparation, the committee has maintained close liaison with both control element manufacturers and major users, especially those of control valves. This practice has been prepared in draft form to permit as broad an industry review as possible before its publication as an ISA Tentative Recommended Practice.

Copies of this draft are available to all those interested in reviewing and commenting on it before its publication as a Tentative Recommended Practice and may be obtained from: F. H. Winterkamp, E. I. duPont de Nemours & Co., Inc., P.O. Box 993, Charleston 24, West Virginia.

Canadian wins mapping award



Gilbert L. Hobrough of Hunting Survey Corp., Toronto, has been given the Fairchild Photogrammetric Award for his contribution to the science of map making—the invention of an electronic automatic system for map making known as Stereomat. The award was made at the annual Washington meeting of the American Society of Photogrammetry.

Stereomat, which replaces human operators in the time-consuming task of constructing contour and relief maps from aerial photographs, can maintain comparable accuracy up to 10 times the speed of a human operator.

Hunting Survey Corp. has also announced that U. S. patents have been issued to them covering Stereomat. The U. S. Army Map Service has awarded a contract to Benson Lehner Corp. of Los Angeles, Hunting's licensee, for the device to be fitted to the latest Wild Stereo Plotter, the B-8. Mr. Hobrough will direct the research and development phases of the program by consultation with Benson Lehner and Army Map Service personnel.

Defence contracts

Unclassified electronics contracts for \$10,000 or more have been awarded to the following Canadian firms by the Department of Defence Production. A figure in parentheses indicates the number of contracts, the amount being the total value.

February 1-15, 1961

- ▶ Burgess Battery Co., Niagara Falls, Ont., batteries, \$23,911.
- ▶ Canadian Aviation Electronics Ltd., Montreal, technical representatives, \$282,036 (2); conversion of radar test sets, \$32,674.
- ▶ Canadian General Electric Co. Ltd., Toronto, tubes, \$11,298; aircraft spares, \$342,296.
- ▶ Canadian Marconi Co., Montreal, broadband amplifiers, \$278,585.
- ▶ Canadian National Telegraphs, Ottawa, maintenance and repair of telephone plant, \$15,014.
- ▶ Canadian Westinghouse Co. Ltd., Ottawa, magnetrons, \$48,064.
- ▶ Collins Radio Co. of Canada Ltd., Toronto, radio transceivers and module kits, \$2,055,879.
- ▶ E.M.I.-Cossor Electronics Ltd., Dartmouth, N.S., testing of sonar equipment, \$10,000.
- ▶ Instronics Ltd., Stittsville, Ont., test equipment and technical publications, \$31,089.
- ▶ Litton Systems (Canada) Ltd., Rexdale, Ont., technical representative, \$36,200.
- ▶ Mallory Battery Co. of Canada Ltd., Toronto, batteries, \$11,270.
- ▶ R. H. Nichols Ltd., Toronto, cable assembly, \$20,258.
- ▶ Perkin-Elmer (Canada) Ltd., Montreal, spectrophotometer, \$18,643.
- ▶ RCA Victor Co. Ltd., Montreal, tubes, \$45,402.
- ▶ Sinclair Radio Laboratories Ltd., Downsview, Ont., development contract, \$10,930.
- ▶ Sperry Gyroscope Co. of Canada Ltd., Montreal, repair and overhaul of gyro compasses and associated equipment, \$48,000.
- ▶ Stewart-Warner Corp. of Canada Ltd., Belleville, support spares for airborne selective identification equipment, \$74,374.
- ▶ Union Carbide Canada Ltd., Toronto, batteries, \$12,555.

February 16-28, 1961

- ▶ Atlas Instrument Corp. Ltd., Toronto, transistor test set, \$10,049.
- ▶ Bayly Engineering Ltd., Ottawa, electrical pens, \$20,140.
- ▶ Bell Telephone Co. of Canada, Montreal, installation of telecommunication equipment, \$53,307; initial phase of installation of communication facilities, \$150,000.
- ▶ De Havilland Aircraft of Canada Ltd., Downsview, Ont., static inverters, \$49,825.
- ▶ E.M.I.-Cossor Electronics Ltd., Dartmouth, N.S., sonobuoy transmitters, \$574,998.

First ... Basics of Digital Computers
Next ... Pressman's Design of Transistorized
Circuits For Digital Computers
... and now

BASICS OF ANALOG COMPUTERS

by Thos. D. Truitt (Director of Advanced Study Group, ELECTRONIC ASSOC., INC.)
 & A. E. Rogers (Senior Consultant, ELECTRONIC ASSOC., INC.)

Anyone having a basic knowledge of engineering or physics will derive great benefit from this remarkable "pictured-text" course (3 volumes in one cloth binding). If you are a practicing engineer, you will be made familiar with the analog computer—with the suitability of this device for your design needs—and with the programming requirements. If you are a training director responsible for training maintenance technicians, or a teacher in a college or a technical institute, you will find this an effective "pictured-text" course that is easy to use. If you are a computer maintenance technician who is ambitious, you can gain a familiarity with this important phase of computing technology. If you are an engineering college student looking toward a computerized technology, you can easily acquire a thorough understanding of the analog computer. More than 400 illustrations reinforce the ideas discussed in the text to make it completely understandable.

Beginning with the simple ideas of analog devices, the book introduces the reader slowly to the mathematical concepts involved, explains in detail the workings of modern general-purpose electronic analog computers and rounds out the course by presenting practical applications of the analog computer.

VOLUME I includes descriptions of many kinds of analog computers and devices including: **INTRODUCTION TO ANALOGS** (what is an analog? analogs and physical laws; problem solving with analogs); **WHY ANALOG?** (analog charac-

teristics, analog devices vs. analog computers; analog computers vs. digital computers); **COMPUTER BUILDING BLOCKS** (building blocks, multipliers, function generators); **MATHEMATICS OF COMPUTING** (variables, integration, differentiation, differential equations, integrators).

VOLUME II gives detailed attention to the computer that is most flexible and easy to use—the D-C Electronic differential analyzer. It includes: **GENERAL PURPOSE COMPUTER TYPES** (passive-element computers, active element computers); **D-C ANALOG COMPUTER: LINEAR COMPUTING COMPONENTS** (attenuators, voltage amplifiers, the summing amplifier, the integrating amplifier); **D-C ANALOG COMPUTER MULTIPLYING COMPONENTS** (the servomultiplier, the electronic multipliers, implicit uses of multipliers); **D-C ANALOG COMPUTER FUNCTION GENERATION** (fixed function generators, variable function generators).

VOLUME III presents some of the programming techniques and interesting applications common to the field of analog computation. It includes: **MONITORING AND CONTROL** (voltmeters, recorders and plotters); **PROGRAMMING AND PROBLEMS** (using the D-C analog computer, automatic programming); **APPLICATIONS** (real time simulation, real time joint analog-digital simulation).

Questions and problems are included at the end of each section to enable you to check your progress. #256-H, 3 vols. in one cloth binding, **\$12.50.**

BASICS OF DIGITAL COMPUTERS ('Pictured-Text' Course) John S. Murphy. Basic theory of computer arithmetic, circuitry, logical building blocks and memory. **JOURNAL OF THE ASSOCIATION FOR COMPUTING MACHINERY** "... the 'picture book' form is extremely effective. The text itself is terse and to the point, and supplemented as it is by pictures on each page turns out to be easy to read and understand. There are no obvious compromises with accuracy of statement for ease of presentation. For the purpose it was written, the book does a very good job; and even for readers who would like to know more about how the machines really work, it is worth reading." 3 vols., #196, soft, **\$8.40**; #196-H, cloth, **\$9.50.**

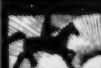
DESIGN OF TRANSISTORIZED CIRCUITS FOR DIGITAL COMPUTERS, Abraham I. Pressman, M.S. Using "worst case" design, this book explains how switching time and drive capabilities and requirements of all the essential digital computer building blocks may be calculated, and how these blocks may be assembled in chains to perform computer-type logical operations. "Worst case" design assures successful operation under all conditions! It saves maintenance time! #215, cloth, **\$9.95.**

VIDEO TAPE RECORDING, Julian L. Bernstein, Instructor, RCA Institutes, Inc.; Member, I.R.E., S.M.P.T.E. The video tape recorder revolutionized the television industry. Here is the only book devoted exclusively to the subject. If there is anything you desire to know about video tape recording—black and white or color electronic photography—the circuitry in the device—the signals in these circuits—the organization of the video tape recorder—the commercial units—the capabilities and limitations of the technique—this book makes it completely understandable. #254, cloth bound, **\$8.95.**

"Mr. Pressman's book gives, to my knowledge, by far the most comprehensive coverage on this subject to date. In general, Mr. Pressman's book is a welcome addition to the literature. It should prove quite useful to circuit designers in the computer field." Reviewed for the **PROCEEDINGS OF THE IRE** by William B. Cagle, Bell Telephone Labs, Whippany, N. J.

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CAMESA News

This bulletin has been prepared for CEE by the Specifications Division, Canadian Military Electronics Standards Agency, Ottawa.

► Specification MIL-S-3928A covering coaxial switches for radio-frequency transmission lines has recently been issued. A number of new requirements and tests have been incorporated in this revision. Detail specifications MIL-S-3928/1, /2, /3, /4 and /5 covering switches SA-185/U, SA-273/U, SA-274/U, SA-275/U and SA-303/U respectively, have also been issued. Specification MIL-S-3928A supersedes MIL-S-3928.

► Specification MIL-S-9372C (USAF) covering heat dissipating shields for electron tubes has recently been issued, together with four Military Standards covering individual tube shield designs. Specification MIL-S-9372C supersedes MIL-S-9372B, and incorporates a locking torque test and an electrical contact test. The latter is intended to ensure satisfactory contact between the shield and the chassis, and between the shield liner and the chassis.

► Specification MIL-C-13777C, which supersedes specification MIL-C-13777B (Ord), has recently been issued. This specification covers special purpose cables for interconnecting complex systems. Changes incorporated in the revision provide for coaxial cable types, the exclusion of all but extruded sheaths, extension of qualification approval to all cable types and modification of Group "C" inspection by deleting the high and low temperature mechanical tests and the low temperature torque test.

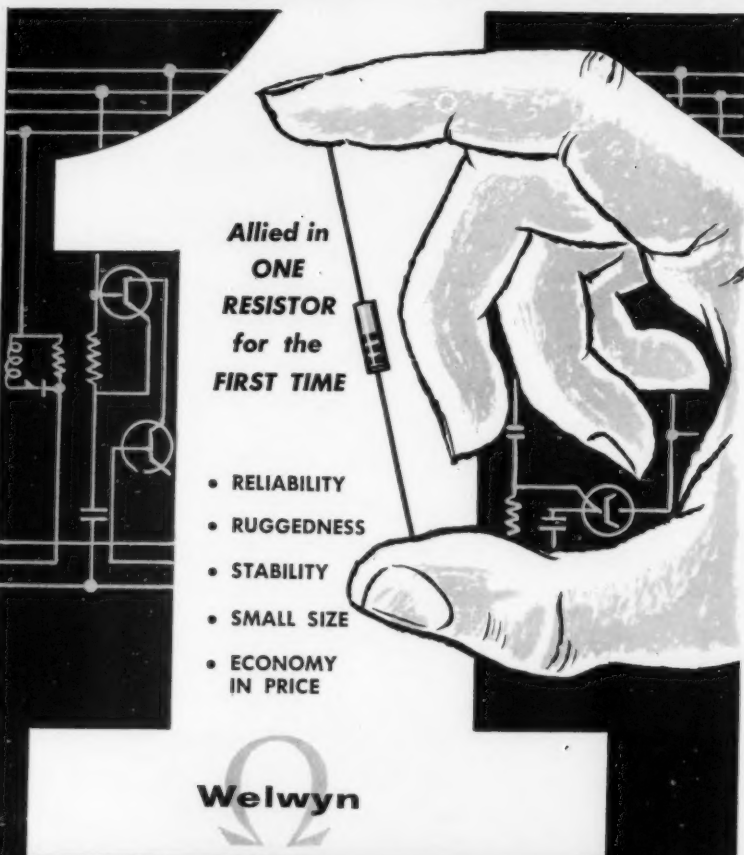
► Specification MIL-P-18177C, covering laminated thermosetting plastic sheet having a glass-fibre base bonded with epoxy resin, has recently been adopted by the Canadian Armed Forces, and issued by CAMESA. Material types GEE and GEB of this specification are called up in Specification MIL-P-13949 covering copper clad laminates for use in printed wiring boards.

► Specification MIL-W-8777B (ASG) superseding specification MIL-W-8777A(ASG) has recently been issued. This specification covers silicone-insulated copper wire designed for operation at a maximum conductor temperature of 200C. Several changes, too numerous to mention here, have

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RELIABILITY — Failure rate is better than one per ten million hours.

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TEMP. COEF. — Will not exceed $\pm 0.05\%$ per $^{\circ}\text{C}$.

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SIZE — Same as the Mil Type RC20.

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PRICE as compelling as the performance and related to 5% carbon composition resistors.

Type	Rating @ 70°C Ambient	Mil Type	Rated Voltage	Minimum Resistance	Maximum Resistance	Dielectric Strength
F20	½ Watt	RC20	350V	10 Ohms	500 K	1000 Volts



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Welwyn Canada Limited

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CANADIAN ELECTRONICS ENGINEERING APRIL 1961

been incorporated in this revision. Military Standard MS25471 (ASG) has also been issued in association with this specification. It covers 14 wire sizes with a polyester jacket.

New components—cont.

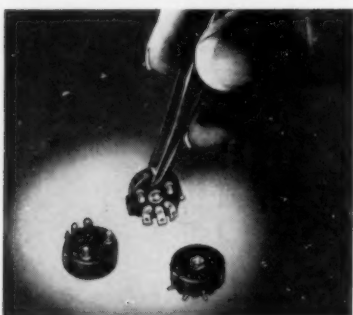
Paper dipped capacitors 130

Type RD paper dipped capacitors are designed for 85 deg. C. operation. They are wax-free units which will not drip or ooze at the operating temperature. They have high power factor, insulation resistance and resistance to humidity. Working voltages are 200, 400, 600, 1,000 and 1,600 vdc. Tolerances are $\pm 10\%$ and $\pm 20\%$; insulation is Durez phenolic resin impregnation. Available capacities range from 0.001 uf. to 0.5 uf.

Capacitors of Canada Ltd., Toronto.

High torque variable resistor 131

A new high torque version of the Model 6 variable resistor is now in production. This is a 1/10-watt composition control with a rotational torque of



1 inch ounce minimum, available in resistances of 500 ohms to 10 megs. Change in resistance is less than 1% under vibration test per MIL-STD 202; less than 0.3% under shock test per MIL-202A; and less than 0.5% under acceleration test per MIL-R-94B. Mechanical rotation is 250 deg.; effective electrical rotation is 220 deg.

Centralab Canada Ltd., Ajax, Ont.

High-temperature neutron detector 132

High temperature ionization chamber type WL-7606 detects thermal neutrons in the range 2.5×10^4 to 2.5×10^{10} neutrons per square centimeter per second. Neutron sensitivity of the boron-lined tube is 4.4×10^{-14} amperes per Roentgen per hour. Gamma sensitivity is 5×10^{-11} amperes per Roentgen per hour. It is equipped with type HN connectors and can operate continuously at temperatures up to 500F.

Canadian Westinghouse Co. Ltd., Hamilton.

(Continued on page 68)

Min Rac 17



**Miniature
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Solve your
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Features:

- Amphenol Patented POKE-HOME contacts
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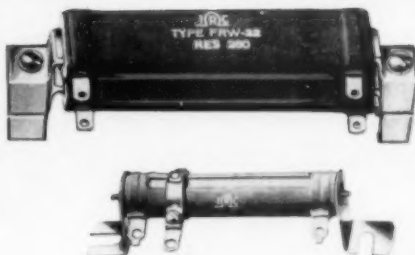


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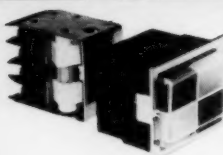
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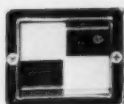
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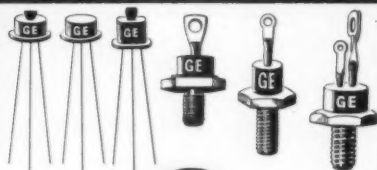
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New components—cont.

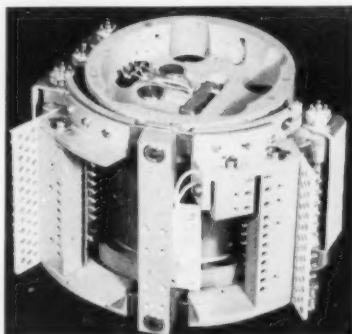
PNP germanium alloy transistors 133

A new series of PNP germanium alloy transistors has been introduced for applications requiring high gain and low noise characteristics. Type 2N1175A has a maximum broad band noise figure of 6 db, measured from 15 cps to 1 kc, and a typical broad band noise figure of 4 db. Type 2N1175 is also a low noise device. The transistors have minimum collector to base voltage ratings of 35 volts, collector to emitter minimum ratings of 25 volts and minimum emitter to base voltage ratings of 10 volts. Both have a typical collector cutoff current of 6 microamperes with a collector to base voltage of 30 volts.

Canadian General Electric Co. Ltd.,
Toronto.

Magnetic memory drum 134

The type 217 magnetic memory drum is suited to airborne computer application. It weighs only 6.5 lb, has a volume of 175 cubic inches and is temperature compensated over the range —20C to + 50C. The drum has a capacity of 50,000 bits on 38 tracks with



an average access time of 2.67 ms at 11,250 rpm. Engraved clock tracks and recirculators are available. It is designed to meet the general design and environmental requirements of MIL-E-5400C Class 2.

Ferranti-Packard Electric Ltd., To-
ronto.

Epitaxial silicon transistors 135

Two ultra-fast silicon switching transistors manufactured by the epitaxial process are now available commercially. The devices will perform their switching function in 24 billionths of a second. They are the first of a family of new epitaxial transistors planned for introduction within a few months. The immediate application of the new devices will be in the computer field, but it is anticipated that the range of usage will increase.

Texas Instruments, Inc., Rexdale, Ont.

(Continued on page 71)

Proceedings of information processing conference

Information processing

Published by UNESCO, Oldenbourg and Butterworths (1960); distributed by Columbia University Press, New York, and by Butterworth & Co. (Canada) Ltd., Toronto; 520 pp; 8½ x 12 in.; \$25.00

The first International Conference on Information Processing was organized by UNESCO and held in Paris during June, 1959. During the planning of the conference, the International Federation of Information Processing Societies was formed. The complete proceedings of the Paris conference including 60 papers with discussions and summaries of 12 symposia, are contained in "Information Processing". Although the contributions came from many countries, 90% of the papers are in English and all abstracts are in English, French, German, Russian and Spanish.

The wide range of subject material is grouped into the following chapters:

I. "Methods of Digital Computing" includes the application of computers to differential equation, numerical analysis, eigenvalue and diophantine problems;

II. "Common Symbolic Language for Computers" deals with automatic programming and code translation methods, especially the international algebraic language ALGOL put forward at the Zurich conference, 1958.

III. "Automatic Translation of Languages" contains detailed reports on projects from Harvard, M.I.T., Rand Corp., Japan and the U.S.S.R.

IV. "Pattern Recognition and Machine Learning" contains papers concerned with automatic figure and letter recognition programs, and the use of digital computers for solving problems and constructing mathematical proofs.

V. "Logical Design of Computers" includes papers on multiplexing multiple computer systems, and on detailed logical design to improve error correcting and speed of computation.

VI. "Computer Techniques of the Future" refers to component techniques such as magnetic films, cryogenics, parametrons, etc.

VII. "Miscellaneous Topics" is the proceedings of three symposia on digital analog computation, error correction and information retrieval. It includes a brief note on Ontario Hy-

dro's modulo seven error checking system for identification numbers.

These proceedings represent a reference work on a variety of aspects of modern information processing. In this sense, they are a more extensive international version of the familiar annual computer conferences. The quality of the papers is excellent and the computer specialist is certain to find interesting and stimulating material. It is the kind of work that is invaluable to a modern computer engineering group.

Reviewed by H. C. Ratz, Assistant Professor of Electrical Engineering, Computer and Control Systems Laboratory, University of Saskatchewan.

Radio Stations: Installation, Design and Practice

G. A. Chappel; Pergamon Press, Inc.; 248 pp; \$7.50

Radio Stations: Installation, Design and Practice has been written from a very general point of view and describes the problems confronting those engaged in high frequency radio station design and installation. In this book emphasis is placed upon the high frequency communication type of station almost to the extent of exclusion of other types of stations.

The broad treatment given the subject in each chapter points out the most important or critical aspects of installations without going into too much design detail. As a result the book may be considered as a guide to construction. Reference to other sources is necessary for detail design data of buildings, antenna and choice of site, etc.

In the first chapter the importance of choosing a proper site for the required service is discussed. The reader is introduced to the significance of ground conductivity and path clearance.

Chapter two deals with the equipment layout and building facilities considered necessary for efficient operation and servicing of multiple transmitters and line terminating equipment.

Because "Radio Stations" deals with the high frequency type of station the chapter on masts and towers is a review of the types in current use with emphasis on those used for suspension of wire aerials and arrays.

(Continued on page 70)

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Here is our new low impedance double triode, the 6080 WA. In the first place, you save space with these two tubes in one envelope. In the second place, here is a really fine, special quality double triode, the result of our 40 years of experience in manufacturing tubes of all kinds. Full information on all Series Stabilisers, including the 6080 WA is available, as well as a detailed report on the design of Series Stabiliser circuits.



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Library—continued

Transmission lines are described in chapter four. Formulas are given for the impedance of various lines ranging from the coaxial type to the multiple wire "open" type. Mechanical details of mounting lines are illustrated.

Rhombic antennas and wide band dipoles are included in a general discussion of the construction of wire aerials. Formulas are given for the mechanical design factors involved.

In commercial message stations it is often required that transmitters or receivers be switched to any one of several antennas. This aspect of operational needs is discussed and illustrated by sketches.

The importance of an adequate ground system is stressed in chapter seven and constructional methods during installation are described.

The remaining five chapters deal with electrical wiring, control units, equipment racks, message distribution and workshop layout. British standards are used in reference to electrical wiring but the author's remarks are very generalized so that the book may be used effectively on a universal basis.

Appendices in the book present typical fault finding and maintenance procedures together with suggested organizations of maintenance depots. Transmitter and receiver remote control systems also are reviewed with typical circuit diagrams.

This book is a good comprehensive review of the current installation practice where high frequency commercial radio stations are involved. Radio broadcasting (for entertainment purposes) does not come under discussion except for brief reference to control room layout.

Reviewed by H. Z. Rogers, P.Eng.,
Broadcast Consultant, Canadian General Electric Co. Ltd., Electronic Equipment and Tube Dept., Toronto.

Catalogues and brochures

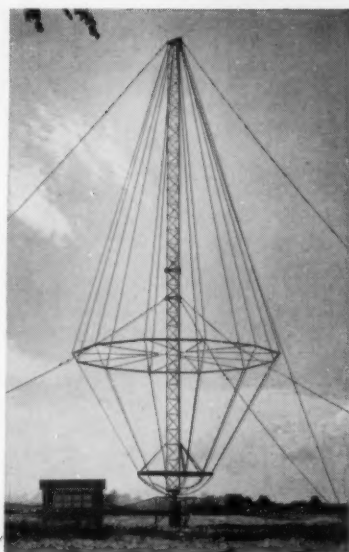
Two wall charts assist designers in selection of optimum silicon and germanium rectifier components for basic circuits. Canadian General Electric Co., Toronto. (215)

Uni-tunnel diode hand book details, with humorous treatment, electrical and physical parameters, testing criteria and circuit applications. Issued by Hoffman Electronics Corp. Aeromotive Engineering Products Ltd., Pointe Claire, Que. (216)

Ceramic-metal resistance element for modular fixed resistors. Technical details on data sheet. CTS of Canada, Ltd., Streetsville, Ont. (217)



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New instruments—cont.

Frequency meter and discriminator 136

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In addition, the instrument can be used to make frequency-drift measurements on oscillators and other generators. By measuring the heterodyne beat between the oscillator and a frequency standard, an accuracy of one part in 10^6 can be obtained. A dc output for operating a recorder is provided. With the aid of a wave analyzer, incidental frequency modulation can be measured down to one part in 10^6 directly; down to one part in 10^6 indirectly. Input sensitivity is 20 millivolts; discriminator residual noise is 100 db below full scale.

General Radio Co., Toronto.

Primer-scope 137

Waterman Primer-Scope Mark I has been designed primarily for educational institutions, hi-fi fans, hams and other electronic enthusiasts. The oscilloscope utilizes both vertical and horizontal amplifiers with ac and dc coupling, variable sweeps with internal and external synchronization, bandwidth from dc to 75 kc, sensitivity of 25 mv rms per inch. Size is $3\frac{1}{2} \times 7 \times 10$ in.; weight is a little over 5 lbs.

Aviation Electric Ltd., Montreal.

RF sweep signal generator 138

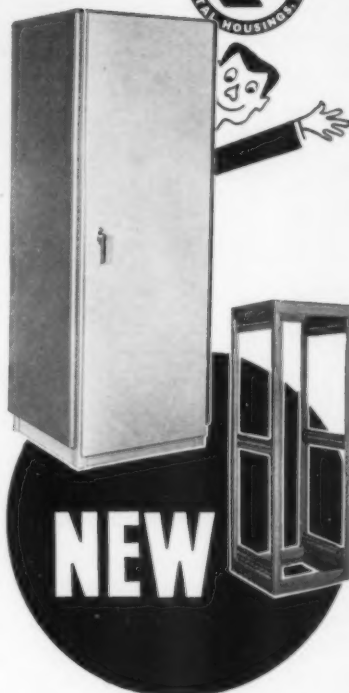
Model 900-B rf sweep signal generator offers a versatile combination of measurement functions between 500 kc and 1,200 Mc. Among its features are: sweep widths as narrow as 10 kc and as broad as 400 Mc; high stability; built-in attenuator, marker generator and scope preamplifier; calibrated centre frequency dial; metered output.

Jerrold Electronics (Canada) Ltd., Toronto.

(Continued on page 72)

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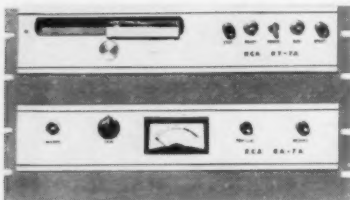
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New equipment—cont.

Cartridge tape recorder

139

This transistorized cartridge tape recorder for broadcasters includes a cue signal for remote equipment control. There are two units: the BA-7A recording amplifier and the RT-7A playback unit. The system is designed for industry compatibility, and will accept standard half-track cartridge tapes.



There is provision for recording program material on one track, and cue-tones on the second track. An oscillator in the record amplifier is used to key a tone on the cue track at the beginning of each recording. This tone will automatically cue each tape at the start of a program.

A feature of the BA-7A recorder is provision for recording of a second cue-tone. This signal, on a different frequency from the first, is inserted on

the cue track at the end of each recording, and will cause the playback unit to trip and start a second recorder while the tape continues to run until stopped by the first cue-tone. Playback units can be run sequentially.

RCA Victor Co. Ltd., Montreal.

Computer link

140

Two computer linkage systems have been developed by Packard Bell Computer on a standard product basis. They link commercial analog computers to IBM 700-7000 series, Bendix G-15, or Packard Bell Computer PB 250 computers. The two basic systems, designated models DS-110 and DS-113 offer 11-bit and 14-bit precision, respectively. Both models are available with up to 30 input and 30 output channels. Conversion accuracy, analog-to-digital and digital-to-analog, is $\pm 0.1\%$ (± 200 mv) for model DS-110, and $\pm 0.05\%$ (± 100 mv) for model DS-113. Resolution is 0.05% (100 mv) and 0.01% (20 mv) respectively.

Intronics Ltd., Stittsville, Ont.

Varactor multiplier

141

Model FM-6 varactor multiplier uses printed strip transmission line resonators at the low frequency of 150 Mc. It replaces the usual vacuum tube stages of the exciter multiplier chain of the transmitter, and of the local oscillator chain of the receiver. Performance character-

istics of the solid state unit are: input frequency, tunable from 145 to 165 Mc; output frequency, tunable from 870 to 990 Mc; output bandwidth, 30 Mc; multiplication factor, $3 \times 2 = 6$; conversion efficiency at 2 w input, -7 db at -20 db spurious output and -8 db at -60 db spurious output; maximum input power, 2 w, operating temperature range, -50°C to $+75^\circ\text{C}$.

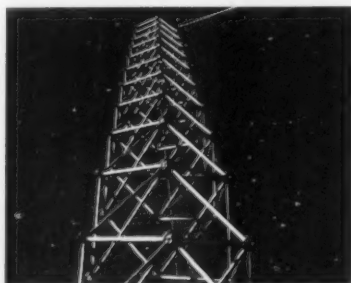
Micromega Corp., Venice, Calif.

Antenna towers

142

High load capabilities and torsional rigidity are features of this octahedron tower. It is quickly erected using just two basic parts: identical struts and ball-shaped joints. Struts are available in aluminum alloy, steel or glass fibre of appropriate lengths, diameters and wall thicknesses for specific tower requirements.

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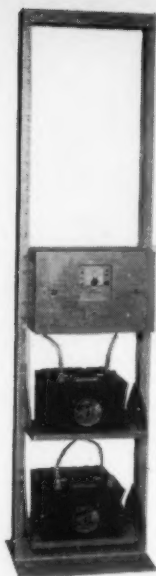
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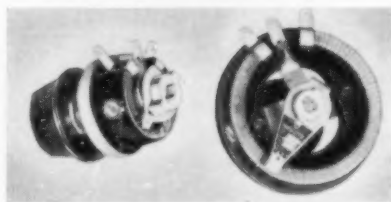
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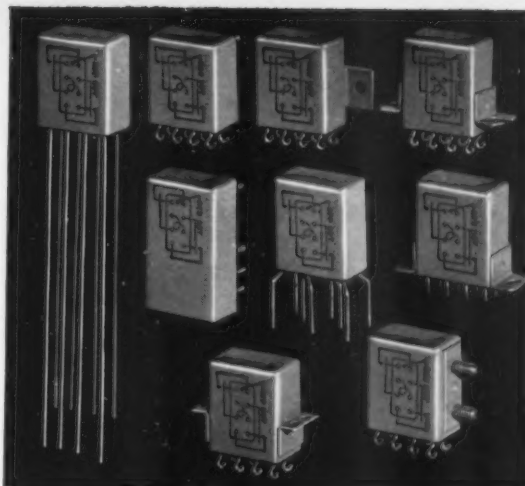
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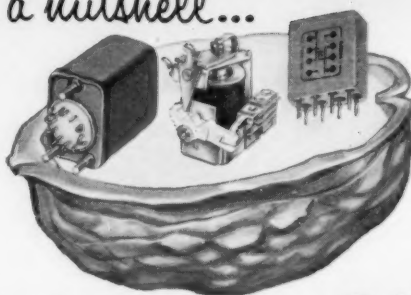
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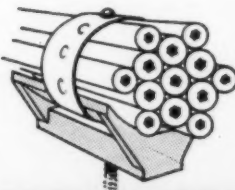
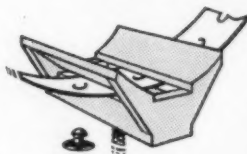
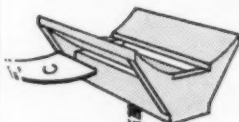
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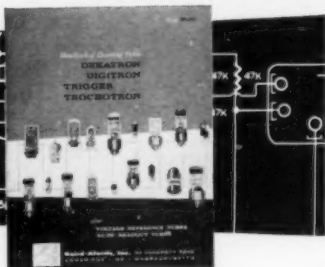
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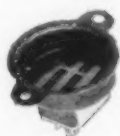
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Large Canadian attendance expected at parts show in Chicago

The keen interest taken by Canadian electronic manufacturers, sales representatives and wholesalers in the Electronic Parts Distributors Show which is held annually in the Conrad Hilton Hotel, Chicago, in May, is evidenced by the growing number of Canadians who attend year after year. The 1961 show, to be held May 22-24, inclusive, promises to be no exception and plans are being made to welcome more Canadians than in any previous year. It is anticipated that a large number of Canadian electronic wholesalers will attend the educational seminars which are provided by the Show Corporation and which have become an important and integral part of the show.

Canadian headquarters will again be established in Room 19 on the fourth floor of the hotel under the exclusive sponsorship of the Canadian Electronic Sales Representatives, of Toronto, of which E. G. Hill is chairman. Here Canadians attending the show can gather and meet other members of the Canadian electronic industry.

The eighteenth annual Canadian reception and luncheon will be held in the Bel Air and Beverly rooms on the third floor on Tuesday, May 23. In attendance, this reception and luncheon is confined only to Canadians and will be under the chairmanship of E. G. Hill. Mr. A. C. Simmonds, President of A. C. Simmonds & Sons Limited, of Toronto, will be guest speaker at this luncheon.

The annual breakfast meeting of the members of the Canadian Electronic Sales Representatives will be held in the Palmer House, Chicago, Monday morning, May 22. This is the year for the biennial elections and 100% attendance of the members is expected.

John T. Rochford will again be in charge of Canadian headquarters.

Nuclear electronics exhibition

The Scientific Exhibition on Nuclear Electronics will be organized at the Belgrade Fair grounds, Belgrade, Yugoslavia, from 13 to 21 May 1961 in connection with the Conference on Nuclear Electronics.

The Government of the Federal Republic of Yugoslavia will be the host government and the International

Atomic Energy Agency will be the sponsor of the exhibition.

The exhibition will be arranged by the Belgrade Fair Administration. The purpose of the exhibition will be to illustrate papers presented at the conference by means of exhibits and to show advanced nuclear electronic equipment and instruments. Due to the specific nature of this exhibition, only exhibits related to the following fields of nuclear electronics will be accepted: scintillation and Cerenkov detectors; ionization gaseous and liquid detectors; semi-conductor detectors; pulse technique in conventional and fast electronics; advanced electronic assemblies used in nuclear research; new developments in radiation monitoring techniques.

Audio engineering papers wanted

The 13th annual Fall Convention and Technical Exhibit of the Audio Engineering Society will be held Oct. 10-13 at the Hotel New Yorker, New York. The committee on technical papers is accepting manuscripts for the four-day convention. Completed papers received by August 15 will be preprinted for the convention. Abstracts of all papers to be included in the program must be sent before August 15 to: Herman H. Scott, chairman, convention committee, Audio Engineering Society, 111 Powder Mill Road, Maynard, Mass.

Topics suggested by the committee include: Disc recording; magnetic tape recording; loudspeakers and systems; artificial reverberation; stereophony; architectural acoustics; amplifiers; standards of measurement and performance; electronic musical instruments; speech analysis and synthesis; compression and expansion; bioacoustics; psychoacoustical engineering.

The cat and mouse game

A few years ago, electronics went to the aid of law enforcement officers and armed them with radar speed measuring equipment. It works very well, as many of us have found out.

Now the engineers, having felt the long arm of the radar beam perhaps, have come up with countermeasure equipment for the motorist. We know of at least two United States and one

Canadian manufacturer turning out small receivers which give an audible tone when approaching a radar speed measuring set.

Next move? The law officers could resort to pulsed radar or other techniques to catch the really dangerous drivers. A series of small radar transmitters could be used to persuade the average driver to stay within the speed limit.

COMING EVENTS

April

11-12 Canadian Military Electronics Symposium, National Gallery, Ottawa.

18-19 Conference on organic semiconductor physics. Armour Research Foundation and "Electronics," Chicago.

May

3-13 British Columbia International Trade Fair, Exhibition Park, Vancouver.

7-12 89th Society of Motion Picture and Television Engineers Convention, King Edward-Sheraton Hotel, Toronto.

8-10 National Aeronautical Electronics Conference, Dayton, Ohio.

8-12 National Industrial Production Show, Exhibition Park, Toronto.

9-17 International Exhibition on measurement, control, regulation and automation, sponsored by the French Mechanical and Electronic Manufacturers Association. Paris, France.

16-17 Annual Meeting and Conference of the Canadian Nuclear Association, Lord Simcoe Hotel, Toronto.

22-24 Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

May 30-June 2 Radio and Electronics Components Show, Olympia, London.

Instrument Society conference

The Instrument Society of America will hold its International Instrument - Automation Conference and Exhibit in Toronto, June 5-8. The May issue of CEE will carry news about exhibits, products and technical sessions of interest to electronics engineers. Other articles and news will be included.

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Covering the high frequency spectrum, (which includes the 30 and 60 MC radar IF bands) the new

606A is exceptionally useful in driving bridges, antennas and filters, and measuring gain, selectivity and image rejection of receivers and IF circuits.

Output is constant within ± 1 db over the full frequency range, and is adjustable from +20 dbm (3 volts rms) to -110 dbm (0.1 μ v rms). No level adjustments are required during operation.

SPECIFICATIONS

Frequency Range: 50 kc to 65 MC in 6 bands.

Frequency Accuracy: Within $\pm 1\%$.

Frequency Calibrator: Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.

RF Output Level: Continuously adjustable from 0.1 μ v to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).

Output Accuracy: Within ± 1 db into 50 ohm resistive load.

Frequency Response: Within ± 1 db into 50 ohm resistive load over entire frequency range at any output level setting.

Output Impedance: 50 ohms. SWR less than 1.1:1 at 0.3 v and below.

Spurious Harmonic Output: Less than 3%.

Leakage: Negligible: permits sensitivity measurements to 0.1 μ v.

Amplitude Modulation: Continuously adjustable from 0 to 100%.

Internal Modulation: 0 to 100% sinusoidal modulation at 400 cps $\pm 5\%$ or 1000 cps $\pm 5\%$.

Modulation Bandwidth: DC to 20 kc maximum.

External Modulation: 0 to 100% sinusoidal modulation dc to 20 kc.

Envelope Distortion: Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.

Spurious FM: Less than 0.0001% or 20 cps, whichever greater.

Spurious AM: Hum and noise sidebands are 70 db below carrier.

Frequency Drift: Less than 0.005% or 3 cps, whichever greater.

Price: (cabinet) \$1,350.00 (rack mount) \$1,335.00.

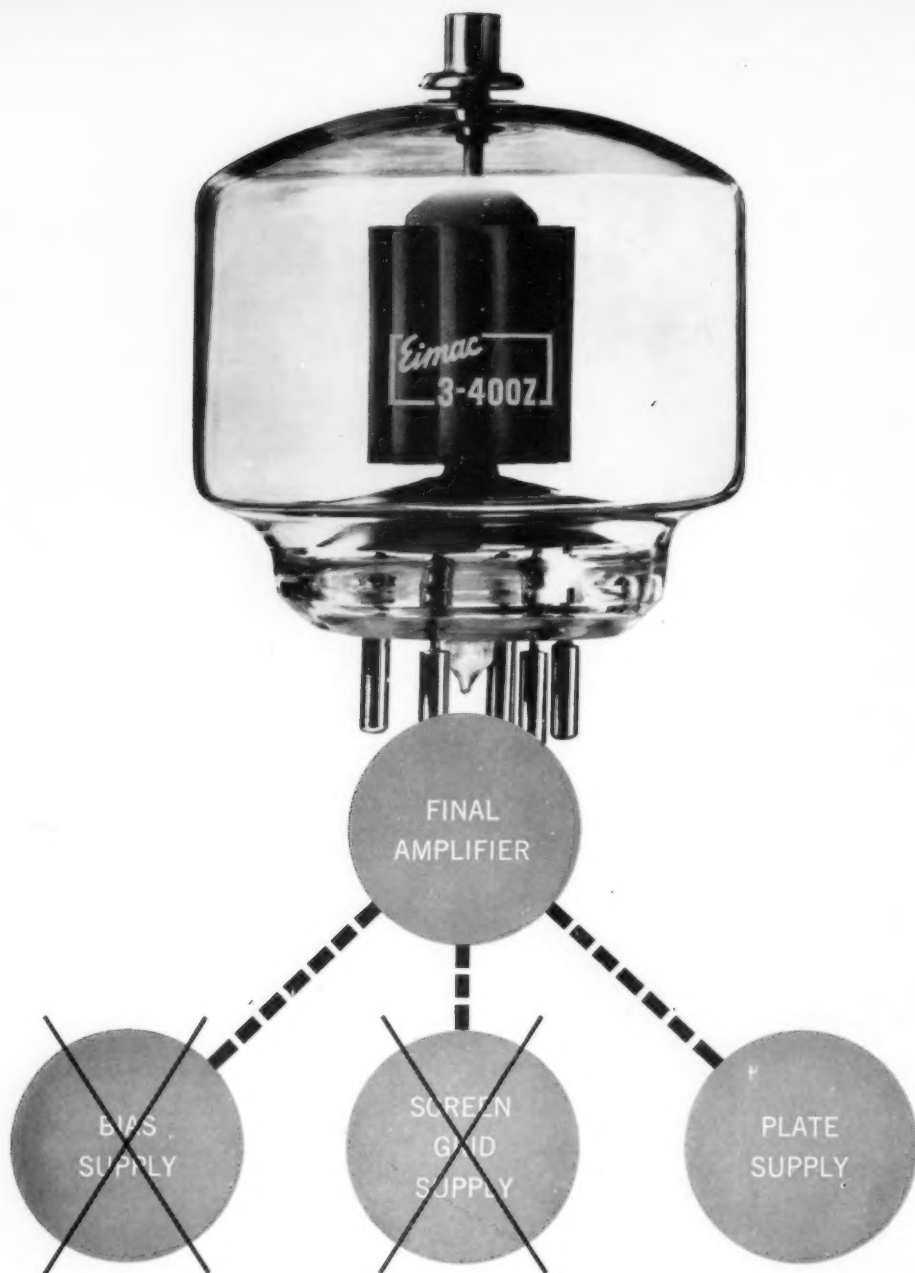
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